

In the Claims:

Kindly amend the claims as follows:

- 1 - 6. (Canceled)
7. (Previously presented) The process of claim 28, further comprising introducing catalyst additives to the electrolyte and thereby contributing to kinetics of the mediated electrochemical processes while keeping the additives from becoming directly involved in the oxidizing Sharps I and sterilizing Sharps II and biological and organic waste materials.
8. (Canceled)
9. (Previously presented) The process of claim 28, wherein the oxidizing species are identified in Table I, and wherein each of the species has normal valence states and higher valence oxidizing states and further comprising creating the higher valence oxidizing states of the oxidizing species by stripping electrons from normal valence state species in the electrochemical cell.
10. (Canceled)
11. (Previously presented) The process of claim 28, further comprising using an alkaline solution, aiding decomposing of the biological and organic materials derived from base promoted ester hydrolysis, saponification, of fatty acids, and forming water soluble alkali metal salts of the fatty acids and glycerin in a process similar to the production of soap from animal fat by introducing it into a hot aqueous lye solution.
12. (Previously presented) The process of claim 28, further comprising using an alkaline anolyte solution for absorbing CO₂ from the oxidizing Sharps I and sterilizing Sharps II and biological and organic waste materials and forming bicarbonate/carbonate solutions, which subsequently circulate through the electrochemical cell, producing percarbonate oxidizers.
- 13 - 14. (Canceled)
15. (Previously presented) The process of claim 95, further comprising impressing an AC voltage upon the direct current voltage for retarding formation of cell performance limiting surface films on the electrode.
16. (Canceled)
17. (Previously presented) The process of claim 95, wherein the catholyte contains HNO₃ or NO₃⁻ salts, and further comprising adding oxygen to the catholyte portion.

18. (Canceled)
19. (Previously presented) The process of claim 28, further comprising adjusting temperature between 0°C and temperature of the anolyte portion before it enters the electrochemical cell for enhancing generation of oxidized forms of the mediator, and adjusting the temperature between 0°C and below the boiling temperature of the anolyte portion entering the anolyte reaction chamber affecting desired chemical reactions at desired rates.
20. (Previously presented) The process of claim 28, further comprising introducing an ultrasonic energy into the anolyte portion, rupturing material structures by momentarily raising local temperature within the material structures with the ultrasonic energy to above several thousand degrees, and causing material structure failure.
21. (Previously presented) The process of claim 96, further comprising feeding the evolving oxygen from the anode to a hydrogen fuel apparatus to increase the percentage oxygen available from the ambient air.
22. (Previously presented) The process of claim 28, further comprising introducing ultraviolet energy into the anolyte portion and decomposing hydrogen peroxide and ozone into hydroxyl free radicals therein, thereby increasing efficiency of the process by converting products of electron consuming parasitic reactions, ozone and hydrogen peroxide, into viable free radical secondary oxidizers without consumption of additional electrons.
23. (Previously presented) The process of claim 28, further comprising adding a surfactant to the anolyte portion for promoting dispersion of the materials or intermediate stage reaction products within the aqueous solution when the materials or reaction products are not water-soluble and tend to form immiscible layers.
24. (Previously presented) The process of claim 28, further comprising attacking specific organic molecules with the oxidizing species while operating at low temperatures and preventing formation of dioxins and furans.
25. (Previously presented) The process of claim 28, further comprising breaking down the biological and organic materials on Sharps I and II into biological and organic compounds and attacking these compounds using as the mediator simple and/or complex anion redox couple mediators or inorganic free radicals and generating organic free radicals.

26. (Previously presented) The process of claim 28, wherein the treating and oxidizing Sharps I and sterilizing Sharps II and biological and organic waste materials comprises treating and oxidizing Sharps I and sterilizing Sharps II and biological waste materials.

27. (Previously presented) The process of claim 28, further comprising raising normal valence state mediator anions to a higher valence state by stripping the mediator anions of electrons in the electrochemical cell, wherein oxidized forms of weaker redox couples present in the mediator are produced by similar anodic oxidation or reaction with oxidized forms of stronger redox couples present and the oxidized species of the redox couples oxidize molecules of the materials and are themselves converted to their reduced form, whereupon they are oxidized by the aforementioned mechanisms and the redox cycle continues.

28. (Currently amended) A process for treating and oxidizing Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials, comprising circulating ions of mediator oxidizing species in an electrolyte through an electrochemical cell and affecting anodic oxidation of reduced forms of reversible redox couples into oxidized forms, contacting the ions with the biological and organic waste in an anolyte portion of the electrolyte in a primary oxidation process, involving super oxidizer anions, having an oxidation potential above a threshold value of 1.7 volts at 1 molar, 25°C and pH1 wherein when said superoxidizers are present there is a free radical oxidizer driven secondary oxidation process, adding energy from an energy source to the anolyte portion and augmenting the secondary oxidation processes, breaking down hydrogen peroxide in the anolyte portion into hydroxyl free radicals, and increasing an oxidizing effect of the secondary oxidation processes.

29. (Original) The process of claim 28, wherein the adding energy comprises irradiating the anolyte portion with ultraviolet energy.

30. (Previously presented) The process of claim 28, wherein the adding energy comprises introducing an ultrasonic energy source into the anolyte portion, irradiating material structures, momentarily raising local temperature within the material structures, causing material structures failure, and creating greater exposure of material structures to oxidizing species in the anolyte portion.

31. (Previously presented) The process of claim 28, wherein the mediator oxidizing species are selected from the group consisting of (a.) simple anions redox couple mediators described in Table I; (b.) Type I isopolyanions formed by Mo, W, V, Nb, Ta, or mixtures

thereof; (c.) Type I heteropolyanions formed by incorporation into the isopolyanions if any of the elements listed in Table II (heteroatoms) either singly or in thereof, or (d.) heteropolyanions containing at least one heteroatom type element contained in both Table I and Table II or combinations of the mediator oxidizing species from any or all of (a.), (b.), (c.) and (d.).

Table I: Simple Ion Redox Couples

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| I | A | None | | | |
| | B | Copper (Cu) | +2 | Cu ⁺² (cupric) HCuO ₂ (bicuprite) CuO ₂ ⁻² (cuprite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Cu ⁺³ CuO ₂ ⁻ (cuprate) Cu ₂ O ₃ (sesquioxide) | |
| | | | +4 | CuO ₂ (peroxide) | |
| | | Silver (Ag) | +1 | Ag ⁺ (argentous) AgO ⁻ (argentite) | +1 Species/ +2, +3 Species; +2 Species/ +3 Species |
| | | | +2 | Ag ⁺² (argentic) AgO (argentic oxide) | |
| | | | +3 | AgO ⁺ (argentlyl) Ag ₂ O ₃ (sesquioxide) | |
| | | Gold (Au) | +1 | Au ⁺ (aurous) | +1 Species/ +3, +4 Species; + 3 Species/ +4 Species |
| | | | +3 | Au ⁺³ (auric) AuO ⁻ (auryl) H ₃ AuO ₃ ⁻ (auric acid) H ₂ AuO ₃ ⁻ (monoaurate) HAuO ₃ ⁻² (diaurate) AuO ₃ ⁻³ (triaurate) Au ₂ O ₃ (auric oxide) Au(OH) ₃ (auric hydroxide) | |
| | | | +4 | AuO ₂ (peroxide) | |
| | | | | | |
| II | A | Magnesium (Mg) | +2 | Mg ⁺² (magnesium) | +2 Species/ +4 Species |
| | | | +4 | MgO ₂ (peroxide) | |
| | | Calcium (Ca) | +2 | Ca ⁺² | +2 Species/ +4 Species |
| | | | +4 | CaO ₂ (peroxide) | |
| | | Strontium | +2 | Sr ⁺² | +2 Species/ +4 Species |
| | | | +4 | SrO ₂ (peroxide) | |
| | | Barium (Ba) | +2 | Ba ⁺² | +2 Species/ +4 Species |
| | | | +4 | BaO ₂ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES | | |
|-------|-----------|--------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| II | B | Zinc (Zn) | +2 | Zn ⁺² (zincic) ZnOH ⁺ (zincyl) HZnO ₂ ⁻ (bizincate) ZnO ₂ ⁻² (zincate) | +2 Species/ +4 Species | | |
| | | | +4 | ZnO ₂ (peroxide) | | | |
| | | Mercury (Hg) | +2 | Hg ⁺² (mercuric) Hg (OH) ₂ (mercuric hydroxide) HHgO ₂ ⁻ (mercuroate) | +2 Species/ +4 Species | | |
| | | | +4 | HgO ₂ (peroxide) | | | |
| | | | | | | | |
| III | A | Boron | +3 | H ₃ BO ₃ (orthoboric acid) H ₂ BO ₃ ⁻ , HBO ₃ ⁻² , BO ₃ ⁻³ (orthoborates) BO ₂ ⁻ (metaborate) H ₂ B ₄ O ₇ (tetraboric acid) HB ₄ O ₇ ⁻ /B ₄ O ₇ ⁻² (tetraborates) B ₂ O ₄ ⁻² (diborate) B ₆ O ₁₀ ⁻² (hexaborate) | +3 Species/ +4.5, +5 Species | | |
| | | | +4.5 | B ₂ O ₅ ⁻ (diborate) | | | |
| | | | +5 | BO ₃ ⁻ /BO ₂ ⁻ •H ₂ O (perborate) | | | |
| | | | Thallium (Tl) | +1 | | Tl ⁺¹ (thallous) | +1 Species/ +3 or +3.33 Species; +3 Species/ +3.33 Species |
| | | | | +3 | | Tl ⁺³ (thallic) TlO ⁺ , TlOH ⁺² , Tl(OH) ₂ ⁺ (thallyl) Tl ₂ O ₃ (sesquioxide) Tl(OH) ₃ (hydroxide) | |
| | | +3.33 | | Tl ₃ O ₅ (peroxide) | | | |
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| | | B | See Rare Earths and Actinides | | | | |
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| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-----------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| IV | A | Carbon (C) | +4 | H ₂ CO ₃ (carbonic acid) HCO ₃ ⁻ (bicarbonate) CO ₃ ⁻² (carbonate) | +4 Species/ +5, +6 Species |
| | | | +5 | H ₂ C ₂ O ₆ (perdicarbonic acid) | |
| | | | +6 | H ₂ CO ₄ (permonocarbonic acid) | |
| | | | | | |
| | | Germanium (Ge) | +4 | H ₂ GeO ₃ (germanic acid) HGeO ₃ ⁻ (bigermaniate) GeO ₃ ⁻⁴ (germinate) Ge ⁺⁴ (germanic) GeO ₄ ⁻⁴ H ₂ Ge ₂ O ₅ (digermanic acid) H ₂ Ge ₄ O ₉ (tetragermanic acid) H ₂ Ge ₅ O ₁₁ (pentagermanic acid) HGe ₅ O ₁₁ ⁻ (bipentagermanate) | +4 Species/ +6 Species |
| | | | +6 | Ge ₅ O ₁₁ ⁻² (pentagermanate) | |
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| | | Tin (Sn) | +4 | Sn ⁺⁴ (stannic) HSnO ₃ ⁻ (bistannate) SnO ₃ ⁻² (stannate) SnO ₂ (stannic oxide) Sn(OH) ₄ (stannic hydroxide) | +4 Species/ +7 Species |
| | | | +7 | SnO ₄ ⁻ (perstannate) | |
| | | | | | |
| | | | | | |
| Lead (Pb) | +2 | Pb ⁺² (plumbous) HPbO ₂ ⁻ (biplumbite) PbOH ⁺ PbO ₂ ⁻² (plumbite) PbO (plumbus oxide) | +2, +2.67, +3 Species/+4 Species | | |
| | +2.67 | Pb ₃ O ₄ (plumbo-plumbic oxide) | | | |
| | +3 | Pb ₂ O ₃ (sequioxide) | | | |
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| IV | A | Lead (Pb) | +4 | Pb ⁺⁴ (plumbic) PbO ₃ ⁻² (metaplumbate) HPbO ₃ ⁻ (acid metaplumbate) PbO ₄ ⁻⁴ (orthoplumbate) PbO ₂ (dioxide) | +2, +2.67, +3 Species/+4 Species |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| IV | B | Titanium | +4 | TiO ⁺² (pertitanyl) HTiO ₄ ⁻ (titanate) TiO ₂ (dioxide) | +4 Species/ +6 Species |
| | | | +6 | TiO ₂ ⁺² (pertitanyl) HTiO ₄ ⁻ (acid pertitanate) TiO ₄ ⁻² (pertitanate) TiO ₃ (peroxide) | |
| | | Zirconium (Zr) | +4 | Zr ⁺⁴ (zirconic) ZrO ⁺² (zirconyl) HZrO ₃ ⁻ (zirconate) | +4 Species/ +5, +6, +7 Species |
| | | | +5 | Zr ₂ O ₅ (pentoxide) | |
| | | | +6 | ZrO ₃ (peroxide) | |
| | | | +7 | Zr ₂ O ₇ (heptoxide) | |
| | | Hafnium (Hf) | +4 | Hf ⁺⁴ (hafnic) HfO ⁺² (hafnyl) | +4 Species/ +6 Species |
| | | | +6 | HfO ₃ (peroxide) | |
| V | A | Nitrogen | +5 | HNO ₃ (nitric acid) NO ₃ ⁻ (nitrate) | +5 species/ +7 Species |
| | | | +7 | HNO ₄ (pernitric acid) | |
| | | Phosphorus (P) | +5 | H ₃ PO ₄ (orthophosphoric acid) H ₂ PO ₄ ⁻ (monoorthophosphate) HPO ₄ ⁻² (diorthophosphate) PO ₄ ⁻³ (triorthophosphate) HPO ₃ (metaphosphoric acid) H ₄ P ₂ O ₇ (pyrophosphoric acid) H ₃ P ₃ O ₁₀ (triphosphoric acid) H ₆ P ₄ O ₁₃ (tetraphosphoric acid) | +5 Species/ +6, +7 species |
| | | | | | |
| V | A | Phosphorus (P) | +6 | H ₄ P ₂ O ₈ (perphosphoric acid) | +5 Species/ +6, +7 Species |
| | | | +7 | H ₃ PO ₅ (monoperphosphoric acid) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| V | A | Arsenic (As) | +5 | H ₃ AsO ₄ (ortho-arsenic acid) H ₂ AsO ₄ ⁻ (mono ortho-arsenate) HAsO ₄ ⁻² (di-ortho-arsenate) AsO ₄ ⁻³ (tri-ortho-arsenate) AsO ₂ ⁺ (arsenyl) | +5 Species/ +7 species |
| | | | +7 | AsO ₃ ⁺ (perarsenyl) | |
| | | Bismuth (Bi) | +3 | Bi ⁺³ (bismuthous) BiOH ⁺² (hydroxybismuthous) BiO ⁺ (bismuthyl) BiO ₂ ⁻ (metabismuthite) | +3 Species/ +3.5, +4, +5 Species |
| | | | +3.5 | Bi ₄ O ₇ (oxide) | |
| | | | +4 | Bi ₂ O ₄ (tetroxide) | |
| | | | +5 | BiO ₃ ⁻ (metabismuthite) Bi ₂ O ₅ (pentoxide) | |
| | | | | | |
| | B | Vanadium (V) | +5 | VO ₂ ⁺ (vanadic) H ₃ V ₂ O ₇ ⁻ (pyrovanadate) H ₂ VO ₄ ⁻ (orthovanadate) VO ₃ ⁻ (metavanadate) HVO ₄ ⁻² (orthovanadate) VO ₄ ⁻³ (orthovanadate) V ₂ O ₅ (pentoxide) H ₄ V ₂ O ₇ (pyrovanadic acid) HVO ₃ (metavanadic acid) H ₄ V ₆ O ₁₇ (hexavanadic acid) | +5 Species/ +7, +9 Species |
| | | | +7 | VO ₄ ⁻ (pervanadate) | |
| | | | +9 | VO ₅ ⁻ (hypervanadate) | |
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| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES | | |
|----------------|-------------------------------------------------------|-------------------------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| V | B | Niobium (Nb) | +5 | NbO ₃ ⁻ (metaniobate) NbO ₄ ⁻³ (orthoniobate) Nb ₂ O ₅ (pentoxide) HNbO ₃ (niobid acid) | +5 Species/ +7 species | | |
| | | | +7 | NbO ₄ ⁻ (perniobate) Nb ₂ O ₇ (perniobic oxide) HNbO ₄ (perniobic acid) | | | |
| | | Tantalum (Ta) | +5 | TaO ₃ ⁻ (metatantalate) TaO ₄ ⁻³ (orthotantalate) Ta ₂ O ₅ (pentoxide) HTaO ₃ (tantalic acid) | +5 species/ +7 species | | |
| | | | +7 | TaO ₄ ⁻ (pentantalate) Ta ₂ O ₇ (pertantalate) HTaO ₄ •H ₂ O (pertantalic acid) | | | |
| | | VI | A | Sulfur (S) | +6 | H ₂ SO ₄ (sulfuric acid) HSO ₄ ⁻ (bisulfate) SO ₄ ⁻² (sulfate) | +6 Species/ +7, +8 Species |
| | | | | | +7 | S ₂ O ₈ ⁻² (dipersulfate) | |
| +8 | H ₂ SO ₅ (momopersulfuric acid) | | | | | | |
| Selenium (Se) | +6 | | | H ₂ Se ₂ O ₄ (selenic acid) HSeO ₄ ⁻ (biselenate) SeO ₄ ⁻² (selenate) | +6 species/ +7 Species | | |
| | +7 | | | H ₂ Se ₂ O ₈ (perdiselenic acid) | | | |
| Tellurium (Te) | +6 | | | H ₂ TeO ₄ (telluric acid) HTeO ₄ ⁻ (bitellurate) TeO ₄ ⁻² (tellurate) | +6 species/ +7 species | | |
| | +7 | | | H ₂ Te ₂ O ₈ (perditellenic acid) | | | |
| Polonium (Po) | +2 | | | Po ⁺² (polonous) | +2, +4 species/ +6 Species | | |
| | +4 | PoO ₃ ⁻² (polonate) | | | | | |
| | +6 | PoO ₃ (peroxide) | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-----------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VI | B | Chromium | +3 | Cr^{+3} (chromic) CrOH^{+2} , $\text{Cr}(\text{OH})_2^+$ (chromyls) CrO_2^- , CrO_3^{-3} (chromites) Cr_2O_3 (chromic oxide) $\text{Cr}(\text{OH})_3$ (chromic hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | CrO_2 (dioxide) $\text{Cr}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | H_2CrO_4 (chromic acid) HCrO_4^- (acid chromate) CrO_4^{-2} (chromate) $\text{Cr}_2\text{O}_7^{-2}$ (dichromate) | |
| | | Molybdenum (Mo) | +6 | HMoO_4^- (bimolybdate) MoO_4^{-2} (molybdate) MoO_3 (molybdic trioxide) H_2MoO_4 (molybolic acid) | +6 Species/ +7 Species |
| | | | +7 | MoO_4^- (permolybdate) | |
| | | Tungsten (W) | +6 | WO_4^{-2} tungstic) WO_3 (trioxide) H_2WO_4 (tungstic acid) | +6 Species/ +8 Species |
| | | | +8 | WO_5^{-2} (pertungstic) H_2WO_5 (pertungstic acid) | |
| | | Chlorine (Cl) | -1 | Cl^- (chloride) | -1 Species/ +1, +3, +5, +7 Species |
| | | | +1 | HClO (hypochlorous acid) ClO^- (hypochlorite) | +1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species; +5 Species/ +7 Species |
| | | | +3 | HClO_2 (chlorous acid) ClO_2^- (chlorite) | |
| | | | +5 | HClO_3 (chloric acid) ClO_3^- (chlorate) | |
| | | | +7 | HClO_4 (perchloric acid) ClO_4^- , HClO_5^{-2} , ClO_5^{-3} , $\text{Cl}_2\text{O}_9^{-4}$ (perchlorates) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| VII | A | Bromine (Br) | -1 | Br ⁻ (bromide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HBrO (hypobromous acid) BrO ⁻ (hypobromite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HBrO ₂ (bromous acid) BrO ₂ ⁻ (bromite) | +5 Species/ +7 Species |
| | | | +5 | HBrO ₃ (bromic acid) BrO ₃ ⁻ (bromate) | |
| | | | +7 | HBrO ₄ (perbromic acid) BrO ₄ ⁻ , HBrO ₅ ⁻² , BrO ₅ ⁻³ , Br ₂ O ₉ ⁻⁴ (prebromates) | |
| | | Iodine | -1 | I ⁻ (iodide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HIO (hypoiodous acid) IO ⁻ (hypoiodite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HIO ₂ (iodous acid) IO ₂ ⁻ (iodite) | +5 Species/ +7 Species |
| | | | +5 | HIO ₃ (iodic acid) IO ₃ ⁻ (iodate) | |
| | | | +7 | HIO ₄ (periodic acid) IO ₄ ⁻ , HIO ₅ ⁻² , IO ₅ ⁻³ , I ₂ O ₉ ⁻⁴ (periodates) | |
| | B | Manganese (Mn) | +2 | Mn ⁺² (manganeous) HMnO ₂ ⁻ (dimanganite) | +2 Species/ +3, +4, +6, +7 Species; +3 Species/ +4, +6, +7 Species; |
| | | | +3 | Mn ⁺³ (manganic) | +4 Species/ +6, +7 Species; |
| | | | +4 | MnO ₂ (dioxide) | +6 Species/ +7 Species |
| | | | +6 | MnO ₄ ⁻² (manganate) | |
| | | | +7 | MnO ₄ ⁻ (permanganate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VIII | Period 4 | Iron (Fe) | +2 | Fe ⁺² (ferrous) HFeO ₂ (dihypoferrite) | +2 Species/+3, +4, +5, +6 Species; |
| VIII | Period 4 | Iron (Fe) | +3 | Fe ⁺³ (ferric) Fe(OH) ⁺² Fe(OH) ₂ ⁺ FeO ₂ ⁻² (ferrite) | +3 Species/+4, +5, +6 Species; |
| | | | +4 | FeO ⁺² (ferryl) FeO ₂ ⁻² (perferrite) | +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +5 | FeO ₂ ⁺ (perferryl) | |
| | | | +6 | FeO ₄ ⁻² (ferrate) | |
| | | Cobalt (Co) | +2 | Co ⁺² (cobalous) HCoO ₂ ⁻ (dicobaltite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Co ⁺³ (cobaltic) Co ₂ O ₃ (cobaltic oxide) | |
| | | | +4 | CoO ₂ (peroxide) H ₂ CoO ₃ (cobaltic acid) | |
| | | Nickel (Ni) | +2 | Ni ⁺² (nickelous) NiOH ⁺ HNiO ₂ ⁻ (dinickelite) NiO ₂ ⁻² (nickelite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Ni ⁺³ (nickelic) Ni ₂ O ₃ (nickelic oxide) | |
| | | | +4 | NiO ₂ (peroxide) | |
| | | | +6 | NiO ₄ ⁻² (nickelate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| VIII | Period 5 | Ruthenium (Ru) | +2 | Ru^{+2} | +2 Species/ +3, +4, +5, +6, +7, +8 Species; |
| | | | +3 | Ru^{+3} Ru_2O_3 (sesquioxide) $\text{Ru}(\text{OH})_3$ (hydroxide) | +3 Species/ +4, +5, +6, +7, +8 Species; +4 Species/ +5, +6, +7, +8 Species; +5 Species/ +6, +7, +8 Species; |
| | | | +4 | Ru^{+4} (ruthenic) RuO_2 (ruthenic dioxide) $\text{Ru}(\text{OH})_4$ (ruthenic hydroxide) | +6 Species/ +7, +8 Species; +7 Species/ +8 Species |
| | | | +5 | Ru_2O_5 (pentoxide) | |
| | | | +6 | RuO_4^{-2} (ruthenate) RuO_2^{+2} (ruthenyl) RuO_3 (trioxide) | |
| | | | +7 | RuO_4^- (perruthenate) | |
| | | | +8 | H_2RuO_4 (hyperuthenic acid) HRuO_5^- (diperruthenate) RuO_4 (ruthenium tetroxide) | |
| | | Rhodium (Rh) | +1 | Rh^+ (hyporhodous) | +1 Species/ +2, +3, +4, +6 Species; |
| | | | +2 | Rh^{+2} (rhodous) | +2 Species/ +3, +4, +6 Species; |
| | | | +3 | Rh^{+3} (rhodic) Rh_2O_3 (sesquioxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | RhO_2 (rhodic oxide) $\text{Rh}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | RhO_4^{-2} (rhodate) RhO_3 (trioxide) | |
| | | Palladium | +2 | Pd^{+2} (palladous) PdO_2^{-2} (palladite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; |
| | | | +3 | Pd_2O_3 (sesquioxide) | +4 Species/ +6 Species |
| | | | +4 | PdO_3^{-2} (palladate) PdO_2 (dioxide) $\text{Pd}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | PdO_3 (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-------------|-------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| VIII | Period 6 | Iridium (Ir) | +3 | Ir ⁺³ (iridic) Ir ₂ O ₃ (iridium sesquioxide) Ir (OH) ₃ (iridium hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | IrO ₂ (iridic oxide) Ir (OH) ₄ (iridic hydroxide) | |
| | | | +6 | IrO ₄ ⁻² (iridate) IrO ₃ (iridium peroxide) | |
| | | Platinum (Pt) | +2 | Pt ⁺² (platinous) | +2, +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Pt ₂ O ₃ (sesquioxide) | |
| | | | +4 | PtO ₃ ⁻² (palatinate) PtO ⁺² (platynyl) Pt(OH) ⁺³ PtO ₂ (platonic oxide) | |
| | | Cerium (Ce) | +3 | Ce ⁺³ (cerous) Ce ₂ O ₃ (cerous oxide) Ce(OH) ₃ (cerous hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | Ce ⁺⁴ , Ce(OH) ⁺³ , Ce(OH) ₂ ⁺² , Ce(OH) ₃ ⁺ (ceric) CeO ₂ (ceric oxide) | |
| | | | +6 | CeO ₃ (peroxide) | |
| IIIB | Rare earths | Praseodymium (Pr) | +3 | Pr ⁺³ (praseodymous) Pr ₂ O ₃ (sesquioxide) Pr(OH) ₃ (hydroxide) | +3 species/ +4 species |
| | | | +4 | Pr ⁺⁴ (praseodymic) PrO ₂ (dioxide) | |
| | | Neodymium | +3 | Nd ⁺³ Nd ₂ O ₃ (sesquioxide) | +3 Species/ +4 Species |
| | | | +4 | NdO ₂ (peroxide) | |
| | | Terbium (Tb) | +3 | Tb ⁺³ Tb ₂ O ₃ (sesquioxide) | +3 Species/ +4 Species |
| | | | +4 | TbO ₂ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| IIIB | Actinides | Thorium (Th) | +4 | Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate) | +4 Species/ +6 Species |
| | | | +6 | ThO ₃ (acid peroxide) | |
| | | Uranium (U) | +6 | UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide) | +6 Species/ +8 Species |
| | | | +8 | HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide) | |
| | | Neptunium (Np) | +5 | NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide) | +5 Species/ +6, +8 Species; +6 Species/ +8 Species |
| | | | +6 | NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide) | |
| | | | +8 | NpO ₄ (peroxide) | |
| | | Plutonium (Pu) | +3 | Pu ⁺³ (hypoplutinous) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Pu ⁺⁴ (plutinous) PuO ₂ (dioxide) | |
| | | | +5 | PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide) | |
| | | | +6 | PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide) | |
| | | Americium (Am) | +3 | Am ⁺³ (hypoamericious) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₄ (hydroxide) | |
| | | | +5 | AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide) | |
| | | | +6 | AmO ₂ ⁺² (americyl) AmO ₃ (peroxide) | |
| | | | | | |

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

| GROUP | SUB GROUP | ELEMENT |
|-------|-------------|-------------------------------------------------------------------------------|
| I | A | Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs) |
| | B | Copper (Cu), Silver (Ag), and Gold (Au) |
| II | A | Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba) |
| | B | Zinc (Zn), Cadmium (Cd), and Mercury (Hg) |
| III | A | Boron (B), and Aluminum (Al) |
| | B | Scandium (Sc), and Yttrium (Y) – (See Rare Earths) |
| IV | A | Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb) |
| | B | Titanium (Ti), Zirconium (Zr), and Hafnium (Hf) |
| V | A | Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi) |
| | B | Vanadium (V), Niobium (Nb), and Tantalum (Ta) |
| VI | A | Sulfur (S), Selenium (Se), and Tellurium (Te) |
| | B | Chromium (Cr), Molybdenum (Mo), and Tungsten (W) |
| VII | A | Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I) |
| | B | Manganese (Mn), Technetium (Tc), and Rhenium (Re) |
| VIII | Period 4 | Iron (Fe), Cobalt (Co), and Nickel (Ni) |
| | Period 5 | Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd) |
| | Period 6 | Osmium (Os), Iridium (Ir), and Platinum (Pt) |
| IIIB | Rare Earths | All |

32. (Previously presented) The process of claim 28, further comprising using oxidizer species that are found in situ in the waste to be decomposed, by circulating the waste-anolyte mixture through the electrochemical cell where in an oxidized form of an in situ reversible redox couple is formed by anodic oxidizing or reacting with an oxidized form of a more powerful redox couple added to the anolyte and anodically oxidized in the electrochemical cell, thereby destroying the biological and organic waste materials, oxidizing Sharps I into metallic ions in solution in the anolyte and sterilizing Sharps II.

33. (Original) The process of claim 28, further comprising using an alkaline electrolyte selected from a group consisting of NaOH or KOH and combinations thereof, with the mediator oxidizing species, wherein a reduced form of a mediator redox couple has sufficient solubility in said electrolyte for allowing desired oxidation of Sharps I and sterilizing Sharps II and destroying biological and organic waste materials.

34. (Original) The process of claim 28, wherein the oxidation potential of redox reactions of the mediator oxidizing species and the biological and organic waste molecules producing hydrogen ions are inversely proportional to electrolyte pH, and thus with a selection of a mediator redox couple increasing the electrolyte pH reduces the electric potential required, thereby reducing electric power consumed per unit mass of the biological and organic waste destroyed.

35. (Previously presented) The process of claim 28, wherein the electrolyte is an aqueous solution chosen from acids, alkalines, neutral, acid and neutral, and alkaline and neutral electrolytes.

36. (Original) The process of claim 28, wherein the adding energy comprises using ultrasonic energy and inducing microscopic bubble expansion and implosion for reducing size of waste volumes dispersed in the anolyte.

37. (Original) The process of claim 28, further comprising interchanging the mediator oxidizing species without changing equipment, and wherein the electrolyte is an acid, neutral or alkaline aqueous solution.

38. (Previously presented) The process of claim 28, wherein the treating and oxidizing Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials comprises treating and oxidizing waste from military ships, submarines, destroyers, cruisers and carriers.

39. (Previously presented) The process of claim 28, wherein the treating and oxidizing Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials comprises treating and oxidizing waste from commercial ships, cruise ships, tankers, cargo ships, fishing boats, recreational craft and houseboats.

40. (Original) The process of claim 28, further comprising separating the anolyte portion and a catholyte portion of the electrolyte with a hydrogen or hydronium ion-permeable membrane, microporous polymer, porous ceramic or glass frit membrane.

41. (Original) The process of claim 28, further comprising electrically energizing the electrochemical cell at a potential level sufficient for forming the oxidized forms of redox couples having highest oxidizing potential in the anolyte, introducing the organic waste into the anolyte portion, forming reduced forms of one or more reversible redox couples by contacting with oxidizable molecules, the reaction with which oxidizes the oxidizable material with the

concomitant reduction of the oxidized form of the reversible redox couples to their reduced form, and wherein the adding energy comprises providing an ultrasonic source connected to the anolyte for augmenting secondary oxidation processes by momentarily heating the hydrogen peroxide in the electrolyte to 4800°C at 1000 atmospheres thereby dissociating the hydrogen peroxide into hydroxyl free radicals thus increasing the oxidizing processes.

42. (Previously presented) The process of claim 41, further comprising oxidation potentials of redox reactions producing hydrogen ions are inversely related to pH.

43. (Original) The process of claim 28, wherein the process is performed at a temperature from slightly above 0°C to slightly below the boiling point of the electrolyte.

44. (Original) The process of claim 43, wherein the temperature at which the process is performed is varied.

45. (Previously presented) The process of claim 28, wherein the treating and Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials comprises treating and oxidizing solid waste.

46. (Previously presented) The process of claim 28, wherein the treating and Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials comprises treating and oxidizing liquid waste.

47. (Previously presented) The process of claim 28, wherein the treating and Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials comprises treating and oxidizing a combination of liquids and solids.

48. (Original) The process of claim 28, further comprising requiring removing and treating precipitates resulting from combinations of the oxidizing species and other species released from the biological and organic waste during destruction and sterilization.

49. (Original) The process of claim 28, further comprising a catholyte portion of the electrolyte, and wherein the anolyte and catholyte portions of electrolyte are independent of one another, and comprise aqueous solutions of acids, alkali or neutral salt.

50. (Previously presented) The process of claim 28, further comprising separating a catholyte portion of the electrolyte from the anolyte portion with a membrane, operating the electrochemical cell at a current density of about 0.5 amp or more per square centimeter across the membrane, and near a limit over which there is the possibility that mediator anions may leak

through the membrane in small quantities, and recovering the mediator anions, thus allowing a greater rate of destruction of materials in the anolyte portion.

51. (Original) The process of claim 28, wherein the catholyte solution further comprises an aqueous solution and the electrolyte in the solution is composed of acids, alkali or neutral salts of strong acids and bases, and further comprising adding oxygen to this solution when HNO_3 or NO_3^- can occur in the catholyte, controlling concentration of electrolyte in the catholyte to maintain conductivity of the catholyte portion desired in the electrochemical cell, providing mechanical mixing and/or ultrasonic energy induced microscopic bubble formation, and implosion for vigorous mixing in the catholyte solution for oxidizing the nitrous acid and small amounts of nitrogen oxides NO_x , introducing air into the catholyte portion for promoting the oxidizing of the nitrous acid and the small amounts of NO_x , and diluting any hydrogen produced in the catholyte portion before releasing the air and hydrogen.

52. (Previously presented) The process of claim 28, further comprising feeding evolving hydrogen to an apparatus that uses hydrogen as a fuel.

53 - 59. (Canceled)

60. (Previously presented) The apparatus of claim 98, wherein the aqueous solutions are derived from carbonate, azide, nitrite, nitrate, phosphite, phosphate, sulfite, sulfate, selenite, thiocyanate, chloride, bromide, and iodide species.

61. (Previously presented) The apparatus of claim 98, further comprising an ultrasonic energy source within or near the anolyte chamber for producing microscopic bubbles and implosions for reducing in size individual second phase waste volumes dispersed in the anolyte.

62. (Previously presented) The apparatus of claim 98, wherein the membrane is made of microporous polymer, porous ceramic or glass frit.

63. (Previously presented) The apparatus of claim 98, further comprising an AC source for impression of an AC voltage upon the DC voltage to retard the formation of cell performance limiting surface films on the electrodes.

64. (Previously presented) The apparatus of claim 98, further comprising an air sparge connected to the catholyte reservoir, whereby oxygen contained in the air oxidizes nitrous acid and the small amounts of nitrogen oxides (NO_x), produced by cathode reactions when HNO_3 or NO_3^- salts are present in the catholyte.

65. (Previously presented) The apparatus of claim 98, wherein each of the oxidizing species has normal valence states in reduced forms of redox couples and higher valence oxidizing states oxidized forms of redox couples of the oxidizing species created by stripping and reducing electrons off normal valence state species in the electrochemical cell.

66. (Previously presented) The apparatus of claim 98, wherein the anolyte portions are alkaline solutions and oxidation potentials of redox reactions producing hydrogen ions are inversely related to pH, which reduces the electrical power required to oxidize Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying the biological and organic waste.

67. (Previously presented) The apparatus of claim 98, wherein the oxidizing species attack specific organic molecules while operating at temperatures sufficiently low so as to preventing the formation of dioxins and furans.

68. (Previously presented) The apparatus of claim 98, wherein the power supply energizes the electrochemical cell at a potential level sufficient to form the oxidized form of the redox couple having the highest oxidation potential in the anolyte, and further comprising a heat exchanger connected to the anolyte chamber for controlling temperature between 0°C and slightly below the boiling temperature of the anolyte with the heat exchanger before the anolyte enters the electrochemical cell enhancing the generation of oxidized forms of the anion redox couple mediator, and adjusting the temperature of the anolyte to the range between 0°C and slightly below the boiling temperature when entering the anolyte reaction chamber.

69. (Previously presented) The apparatus of claim 98, wherein the oxidizing species are one or more Type I isopolyanion complex anion redox couple mediators containing tungsten, molybdenum, vanadium, niobium, tantalum, or combinations thereof as addenda atoms in aqueous solution;

70. (Original) The apparatus of claim 69, wherein the oxidizing species are one or more Type I heteropolyanions formed by incorporation into the isopolyanions, as heteroatoms, of the elements listed in Table II, either singly or in combination thereof.

71. (Previously presented) The apparatus of claim 98, wherein the oxidizing species are one or more heteropolyanions containing at least one heteroatom type element contained in Table I and Table II.

72. (Previously presented) The apparatus of claim 98, wherein the oxidizing species are higher valence state of species found in situ for destroying of Sharps I into ions in solution in the anolyte and the sterilizing of Sharps and the destroying of biological and organic waste materials.

73. (Previously presented) The apparatus of claim 98, wherein the waste material contains pharmaceutical materials in the biological and organic materials on the Sharps I and II.

74. (Previously presented) The apparatus of claim 98, wherein the membrane is hydrogen or hydronium ion semi permeable or ion-selective, microporous polymer, porous ceramic or glass frit membrane for separating the anolyte portion and the catholyte portion while allowing hydrogen or hydronium ion passage from the anolyte to the catholyte.

75. (Previously presented) The apparatus of claim 98, wherein oxidation potentials of redox reactions producing hydrogen ions are inversely related to pH, the biological and organic waste is liquid or solid, or a combination of liquids and solids, and the oxidizing species are interchangeable without changing other elements of the apparatus.

76. (Previously presented) The apparatus of claim 98, further comprising an ultraviolet source connected to the anolyte chamber for decomposing hydrogen peroxide and ozone into hydroxyl free radicals as secondary oxidizers and increasing efficiency of the process by recovering energy through the oxidation of the materials in the anolyte chamber by the secondary oxidizers.

77. (Previously presented) The apparatus of claim 98, further comprising an ultrasonic source connected to the anolyte for augmenting secondary oxidation processes by irradiating the anolyte for dissociating hydrogen peroxide into hydroxyl free radicals and thus increasing concentration of oxidizing species and rate of waste destruction.

78. (Previously presented) The apparatus of claim 98, further comprising use of ultrasonic energy, via the ultrasonic energy source communicating with the anolyte for inducing microscopic bubble implosions to affect a reduction in size of the individual second phase waste volumes dispersed in the anolyte.

79. (Previously presented) The apparatus of claim 98, further comprising an anolyte reaction chamber holding most of the anolyte portion and a foraminous basket, a penetrator attached to the basket to puncture solids increasing the exposed area, and further comprising an external CO₂ vent connected to the reaction chamber for releasing CO₂ into the atmosphere, a

hinged lid attached to the reaction chamber allowing insertion of waste into the anolyte portion as liquid, solid, or mixtures of liquids and solids, an anolyte pump connected to the reaction chamber, an inorganic compounds removal and treatment system connected to the anolyte pump for removing chlorides, and other precipitate forming anions present in the biological and organic waste being processed, thereby precluding formation of unstable oxycompounds.

80. (Original) The apparatus of claim 79, further comprising an off-gas cleaning system, comprising scrubber/absorption columns connected to the vent, a condenser connected to the anolyte reaction chamber, whereby non-condensable incomplete oxidation products, low molecular weight organics and carbon monoxide are reduced to acceptable levels for atmospheric release by the gas cleaning system, and wherein the anolyte off-gas is contacted in the gas cleaning system wherein the noncondensibles from the condenser are introduced into the lower portion of the gas cleaning system through a flow distribution system and a small side stream of freshly oxidized anolyte direct from the electrochemical cell is introduced into the upper portion of the column, resulting in a gas phase continuously reacting with the oxidizing mediator species as it rises up the column past the down flowing anolyte, and external drain, for draining to an organic compound removal system and the inorganic compounds removal and treatment system, and for draining the anolyte system, wherein the organic compounds recovery system is used to recover biological materials that are benign and do not need further treatment, and biological materials that will be used in the form they have been reduced.

81. (Original) The apparatus of claim 79, further comprising thermal control units connected to heat or cool the anolyte to a selected temperature range when anolyte is circulated into the reaction chamber through the electrochemical cell by pump on the anode chamber side of the membrane, a flush for flushing the anolyte, and a filter is located at the base of the reaction chamber to limit the size of exiting solid particles to approximately 1mm in diameter.

82. (Previously presented) The apparatus of claim 98, wherein the direct current for the electrochemical cell is provided by a DC power supply, which is powered by an AC power supply, and wherein the DC power supply is low voltage high current supply operating at or below 10V DC.

83. (Previously presented) The apparatus of claim 98, further comprising an electrolyte containment boundary composed of materials resistant to the oxidizing electrolyte

selected from a group consisting of stainless steel, PTFE, PTFE lined tubing, glass and ceramics, and combinations thereof.

84. (Previously presented) The apparatus of claim 98, further comprising an anolyte recovery system connected to a catholyte pump, a catholyte reservoir connected to the cathode portion of the electrochemical cell, a thermal control unit connected to the catholyte reservoir for varying the temperature of the catholyte portion, a bulk of the catholyte portion being resident in a catholyte reservoir, wherein the catholyte portion of the electrolyte flows into a catholyte reservoir, and further comprising an air sparge connected to the catholyte reservoir for introducing air into the catholyte reservoir.

85. (Original) The apparatus of claim 84, further comprising an anolyte recovery system for capturing the anions and for reintroducing the anions into the anolyte chamber upon collection from the catholyte electrolyte, an off-gas cleaning system connected to the catholyte reservoir for cleaning gases before release into the atmosphere, and an atmospheric vent connected to the off-gas cleaning system for releasing gases into the atmosphere, wherein cleaned gas from the off-gas cleaning system is combined with unreacted components of the air introduced into the system and discharged through the atmospheric vent 47.

86. (Original) The apparatus of claim 84, further comprising a screwed top on the catholyte reservoir to facilitate flushing out the catholyte reservoir, a mixer connected to the catholyte reservoir for stirring the catholyte, a catholyte pump connected to the catholyte reservoir for circulating catholyte back to the electrochemical cell, a drain for draining catholyte, a flush for flushing the catholyte system, and an air sparge connected to the housing for introducing air into the catholyte reservoir, wherein the catholyte portion of the electrolyte is circulated by pump through the electrochemical cell on the cathode side of the membrane, and wherein contact of oxidizing gas with the catholyte portion of the electrolyte is enhanced by promoting gas/liquid contact by mechanical and/or ultrasonic mixing.

87. (Previously presented) The apparatus of claim 98, wherein the electrochemical cell is operated at high membrane current densities above about 0.5 amps/cm² for increasing a rate of waste destruction, also results in increased mediator ion transport through the membrane into the catholyte, and further comprising an anolyte recovery system positioned on the catholyte side, air sparging on the catholyte side to dilute and remove off-gas and hydrogen, wherein some

mediator oxidizer ions cross the membrane and are removed through the anolyte recovery system to maintain process efficiency or cell operability.

88. (Previously presented) The apparatus of claim 98, further comprising a controller, a microprocessor, a monitor and a keyboard connected to the cell for inputting commands to the controller through the keyboard responding to the information displayed on the monitor, a program in the controller sequencing the steps for operation of the apparatus, program having pre-programmed sequences of operations the operator follows or chooses other sequences of operations, the controller allows the operator to select sequences within limits that assure a safe and reliable operation, the controller sends digital commands that regulate electrical power to pumps, mixers, thermal controls, ultraviolet sources, ultrasonic sources, CO₂ vents, air sparge, and the electrochemical cell, the controller receives component response and status from the components, the controller sends digital commands to the sensors to access sensor information through sensor responses, sensors in the apparatus provide digital information on the state of components, sensors measure flow rate, temperature, pH, CO₂ venting, degree of oxidation, and air sparging, the controller receives status information on electrical potential across the electrochemical cell or individual cells in a multi-cell configuration and between the anodes and reference electrodes internal to the cells and the current flowing between the electrodes within each cell.

89. (Currently amended) A organic waste destruction system, comprising a housing constructed of metal or high strength plastic surrounding an electrochemical cell, with electrolyte and a foraminous basket, an AC power supply with a power cord, a DC power supply connected to the AC power supply, the DC power supply providing direct current to the electrochemical cell, a control keyboard for input of commands and data, a monitor screen to display the systems operation and functions, an anolyte reaction chamber with a basket, ~~status lights~~ means for displaying information about the status of the treatment of the organic waste material, an air sparge for introducing air into a catholyte reservoir below a surface of a catholyte, a CO₂ vent incorporated into the housing to allow for CO₂ release from the anolyte reaction chamber, an atmospheric vent facilitating the releases of gases into the atmosphere from the catholyte reservoir, a hinged lid for opening and depositing the organic waste in the basket in the anolyte reaction chamber, a locking latch connected to the hinged lid, and in the anolyte reaction chamber an aqueous acid, alkali, or neutral salt electrolyte and mediated oxidizer species

solution in which an oxidizer form of a mediator redox couple initially may be present or may be generated electrochemically after introduction of the waste and application of DC power to the electrochemical cell.

90. (Original) The system of claim 89, wherein the waste is introduced when the anolyte is at room temperature, operating temperature or intermediate temperature, and the organic waste material is rapidly oxidized at temperatures below boiling point of anolyte at ambient pressure, and further comprising a pump circulating an anolyte portion of an electrolyte, an in-line filter preventing solid particles large enough to clog electrochemical cell flow paths from exiting the reaction chamber, an inorganic compound removal and treatment system and drain outlets connected to the anolyte reaction chamber, whereby residue is pacified in the form of a salt and may be periodically removed, and a removable top connected to a catholyte reservoir allowing access to the reservoir for cleaning and maintenance.

91. (Original) A organic waste oxidizing process, comprising an operator engaging an 'ON' button on a control keyboard, a system controller which contains a microprocessor, running a program and controlling a sequence of operations, a monitor screen displaying process steps in proper sequence, status lights on the panel providing status of the process, opening a lid and placing the organic waste in a basket as a liquid, solid, or a mixture of liquids and solids, retaining a solid portion of the waste and flowing a liquid portion through the basket and into an anolyte reaction chamber, activating a locking latch after the waste is placed in the basket, activating pumps which begins circulating the anolyte and a catholyte, once the circulating is established throughout the system, operating mixers, once flow is established, turning on thermal control units, and initiating anodic oxidation and electrolyte heating programs, energizing an electrochemical cell to electric potential and current density determined by the controller program, using programmed electrical power and electrolyte temperature ramps for maintaining a predetermined waste destruction rate profile as a relatively constant reaction rate as more reactive waste components are oxidized, thus resulting in the remaining waste becoming less and less reactive, thereby requiring more and more vigorous oxidizing conditions, activating ultrasonic and ultraviolet systems in the anolyte reaction chamber and catholyte reservoir, releasing CO₂ from the biological and organic waste oxidizing process in the anolyte reaction chamber, activating air sparge and atmospheric vent in a catholyte system, monitoring progress of the process in the controller by cell voltages and currents, monitoring CO₂, CO, and O₂ gas

composition for CO₂, CO and oxygen content, decomposing the organic waste into water and CO₂, the latter being discharged out of the CO₂ vent, air sparging drawing air into a catholyte reservoir, and discharging excess air out of an atmospheric vent, determining with an oxidation sensor that desired degree of waste destruction has been obtained, setting the system to standby, and executing system shutdown using the controller keyboard system operator.

92. (Original) The process of claim 91, further comprising placing the system in a standby mode during the day and adding organic waste as it is generated throughout the day, placing the system in full activation during non-business hours, operating the system at low temperature and ambient atmospheric pressure and not generating toxic compounds during the oxidation of Sharps I into metallic ions in solution in the anolyte and sterilizing of sharps II and the destroying of the biological and organic waste, making the process indoors compatible, scaling the system between units small enough for use by a single practitioner and units large enough to replace hospital incinerators, releasing CO₂ oxidation product from the anolyte system out through the CO₂ vent, and venting off-gas products from the catholyte reservoir through the atmospheric vent.

93. (Original) The process of claim 91, further comprising introducing the waste into a room temperature or cooler system with little or none of the mediator redox couple in the oxidizer form, depending upon reaction kinetics, heat of reaction and similar waste characteristics.

94. (Previously presented) The system of claim 89, wherein the system is room temperature or cooler with little or none of the mediator redox couple in the oxidizer form, depending upon reaction kinetics, heat of reaction and similar waste characteristics.

95. (Previously presented) A process for treating and oxidizing Sharps I and sterilizing Sharps II and waste materials comprising disposing an electrolyte in an electrochemical cell, separating the electrolyte into an anolyte portion and a catholyte portion with an ion-selective membrane, semipermeable membrane, microporous polymer, porous ceramic, or glass frit, applying a direct current voltage between the anolyte portion and the catholyte portion, placing the sharps and waste in the anolyte portion, and oxidizing the Sharps I into metallic ions in solution in the anolyte, sterilizing Sharps II, and waste in the anolyte portion with a mediated electrochemical oxidation (MEO) process, wherein the anolyte portion further comprises oxidizing species as a mediator in aqueous solution and the

electrolyte is an acid, neutral or alkaline aqueous solution, and wherein the mediator oxidizing species are selected from the group consisting of (a.) simple ion redox couples described in Table I as below; (b.) Type I isopolyanions complex anion redox couples formed by incorporation of elements in Table I or mixtures thereof as addenda atoms; (c.) Type I heteropolyanions complex anion redox couples formed by incorporation into Type I isopolyanions as heteroatoms any element selected from the group consisting of the elements listed in Table II either singly or in combination thereof, or (d.) heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or (e.) combinations of the mediator oxidizing species from any or all of (a.), (b.), (c.), and (d.)

Table I: Simple Ion Redox Couples

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| I | A | None | | | |
| | B | Copper (Cu) | +2 | Cu ⁺² (cupric) HCuO ₂ (bicuprite) CuO ₂ ⁻² (cuprite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Cu ⁺³ CuO ₂ ⁻ (cuprate) Cu ₂ O ₃ (sesquioxide) | |
| | | | +4 | CuO ₂ (peroxide) | |
| | | Silver (Ag) | +1 | Ag ⁺ (argentous) AgO ⁻ (argentite) | +1 Species/ +2, +3 Species; +2 Species/ +3 Species |
| | | | +2 | Ag ⁺² (argentic) AgO (argentic oxide) | |
| | | | +3 | AgO ⁺ (argetyl) Ag ₂ O ₃ (sesquioxide) | |
| | | Gold (Au) | +1 | Au ⁺ (aurous) | +1 Species/ +3, +4 Species; + 3 Species/ +4 Species |
| | | | +3 | Au ⁺³ (auric) AuO ⁻ (auryl) H ₃ AuO ₃ ⁻ (auric acid) H ₂ AuO ₃ ⁻ (monoaurate) HAuO ₃ ⁻² (diaurate) AuO ₃ ⁻³ (triaurate) Au ₂ O ₃ (auric oxide) Au(OH) ₃ (auric hydroxide) | |
| | | | +4 | AuO ₂ (peroxide) | |
| | | | | | |
| II | A | Magnesium (Mg) | +2 | Mg ⁺² (magnestic) | +2 Species/ +4 Species |
| | | | +4 | MgO ₂ (peroxide) | |
| | | Calcium | +2 | Ca ⁺² | +2 Species/ +4 Species |

| | | | | |
|--|-------------|----|-----------------------------|------------------------|
| | (Ca) | | | |
| | | +4 | CaO ₂ (peroxide) | |
| | Strontium | +2 | Sr ⁺² | +2 Species/ +4 Species |
| | | +4 | SrO ₂ (peroxide) | |
| | Barium (Ba) | +2 | Ba ⁺² | +2 Species/ +4 Species |
| | | +4 | BaO ₂ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------------------------|---------|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| II | B | Zinc (Zn) | +2 | Zn ⁺² (zincic) | +2 Species/ +4 Species |
| | | | | ZnOH ⁺ (zincyl) HZnO ₂ ⁻ (bizincate) ZnO ₂ ⁻² (zincate) | |
| | | | +4 | ZnO ₂ (peroxide) | |
| | | Mercury (Hg) | +2 | Hg ⁺² (mercuric) | +2 Species/ +4 Species |
| | | | | Hg (OH) ₂ (mercuric hydroxide) HHgO ₂ ⁻ (mercurate) | |
| | | | +4 | HgO ₂ (peroxide) | |
| III | A | Boron | +3 | H ₃ BO ₃ (orthoboric acid) | +3 Species/ +4.5, +5 Species |
| | | | | H ₂ BO ₃ ⁻ , HBO ₃ ⁻² , BO ₃ ⁻³ (orthoborates) | |
| | | | | BO ₂ ⁻ (metaborate) | |
| | | | | H ₂ B ₄ O ₇ (tetraboric acid) | |
| | | | | HB ₄ O ₇ ⁻ /B ₄ O ₇ ⁻² (tetraborates) | |
| | | | | B ₂ O ₄ ⁻² (diborate) | |
| | | | | B ₆ O ₁₀ ⁻² (hexaborate) | |
| | | | +4.5 | B ₂ O ₅ ⁻ (diborate) | |
| | | | +5 | BO ₃ ⁻ /BO ₂ ⁻ ·H ₂ O (perborate) | |
| | B | Thallium (Tl) | +1 | Tl ⁺¹ (thallous) | +1 Species/ +3 or +3.33 Species; +3 Species/ +3.33 Species |
| | | | +3 | Tl ⁺³ (thallic) | |
| | | | | TlO ⁺ , TlOH ⁺² , Tl(OH) ₂ ⁺ (thallyl) | |
| | | | | Tl ₂ O ₃ (sesquioxide) Tl(OH) ₃ (hydroxide) | |
| | | | +3.33 | Tl ₃ O ₅ (peroxide) | |
| | B | See Rare Earths and Actinides | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| IV | A | Carbon (C) | +4 | H ₂ CO ₃ (carbonic acid) HCO ₃ ⁻ (bicarbonate) CO ₃ ⁻² (carbonate) | +4 Species/ +5, +6 Species |
| | | | +5 | H ₂ C ₂ O ₆ (perdicarbonic acid) | |
| | | | +6 | H ₂ CO ₄ (permonocarbonic acid) | |
| | | Germanium (Ge) | +4 | H ₂ GeO ₃ (germanic acid) HGeO ₃ ⁻ (bigermaniate) GeO ₃ ⁻⁴ (germinate) Ge ⁺⁴ (germanic) GeO ₄ ⁻⁴ H ₂ Ge ₂ O ₅ (digermanic acid) H ₂ Ge ₄ O ₉ (tetragermanic acid) H ₂ Ge ₅ O ₁₁ (pentagermanic acid) HGe ₅ O ₁₁ ⁻ (bipentagermanate) | +4 Species/ +6 Species |
| | | | +6 | Ge ₃ O ₁₁ ⁻² (pentagermanate) | |
| | | Tin (Sn) | +4 | Sn ⁺⁴ (stannic) HSnO ₃ ⁻ (bistannate) SnO ₃ ⁻² (stannate) SnO ₂ (stannic oxide) Sn(OH) ₄ (stannic hydroxide) | +4 Species/ +7 Species |
| | | | +7 | SnO ₄ ⁻ (perstannate) | |
| | | Lead (Pb) | +2 | Pb ⁺² (plumbous) HPbO ₂ ⁻ (biplumbite) PbOH ⁺ PbO ₂ ⁻² (plumbite) PbO (plumbus oxide) | +2, +2.67, +3 Species/+4 Species |
| | | | +2.67 | Pb ₃ O ₄ (plumbo-plumbic oxide) | |
| | | | +3 | Pb ₂ O ₃ (sequioxide) | |
| | | Lead (Pb) | +4 | Pb ⁺⁴ (plumbic) | +2, +2.67, +3 Species/+4 Species |
| | | | | PbO ₃ ⁻² (metaplumbate) | |
| | | | | HPbO ₃ ⁻ (acid metaplumbate) | |
| | | | | PbO ₄ ⁻⁴ (orthoplumbate) | |
| | | | | PbO ₂ (dioxide) | |
| IV | A | Lead (Pb) | +4 | Pb ⁺⁴ (plumbic) | +2, +2.67, +3 Species/+4 Species |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| IV | B | Titanium | +4 | TiO ⁺² (pertitanyl) HTiO ₄ ⁻ titanate TiO ₂ (dioxide) | +4 Species/ +6 Species |
| | | | +6 | TiO ₂ ⁺² (pertitanyl) HTiO ₄ ⁻ (acid pertitanate) TiO ₄ ⁻² (pertitanate) TiO ₃ (peroxide) | |
| | | Zirconium (Zr) | +4 | Zr ⁺⁴ (zirconic) ZrO ⁺² (zirconyl) HZrO ₃ ⁻ (zirconate) | +4 Species/ +5, +6, +7 Species |
| | | | +5 | Zr ₂ O ₅ (pentoxide) | |
| | | | +6 | ZrO ₃ (peroxide) | |
| | | | +7 | Zr ₂ O ₇ (heptoxide) | |
| | | Hafnium (Hf) | +4 | Hf ⁺⁴ (hafnic) HfO ⁺² (hafnyl) | +4 Species/ +6 Species |
| | | | +6 | HfO ₃ (peroxide) | |
| V | A | Nitrogen | +5 | HNO ₃ (nitric acid) NO ₃ ⁻ (nitrate) | +5 species/ +7 Species |
| | | | +7 | HNO ₄ (pernitric acid) | |
| | | Phosphorus (P) | +5 | H ₃ PO ₄ (orthophosphoric acid) H ₂ PO ₄ ⁻ (monoorthophosphate) HPO ₄ ⁻² (diorthophosphate) PO ₄ ⁻³ (triorthophosphate) HPO ₃ (metaphosphoric acid) H ₄ P ₂ O ₇ (pyrophosphoric acid) H ₅ P ₃ O ₁₀ (triphosphoric acid) H ₆ P ₄ O ₁₃ (tetraphosphoric acid) | +5 Species/ +6, +7 species |
| V | A | Phosphorus (P) | +6 | H ₄ P ₂ O ₈ (perphosphoric acid) | +5 Species/ +6, +7 Species |
| | | | +7 | H ₃ PO ₅ (monoperphosphoric acid) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| V | A | Arsenic (As) | +5 | H ₃ AsO ₄ (ortho-arsenic acid) H ₂ AsO ₄ ⁻ (mono ortho-arsenate) HAsO ₄ ⁻² (di-ortho-arsenate) AsO ₄ ⁻³ (tri-ortho-arsenate) AsO ₂ ⁺ (arsenyl) | +5 Species/ +7 species |
| | | | +7 | AsO ₃ ⁺ (perarsenyl) | |
| | | Bismuth (Bi) | +3 | Bi ⁺³ (bismuthous) BiOH ⁺² (hydroxybismuthous) BiO ⁺ (bismuthyl) BiO ₂ ⁻ (metabismuthite) | +3 Species/ +3.5, +4, +5 Species |
| | | | +3.5 | Bi ₄ O ₇ (oxide) | |
| | | | +4 | Bi ₂ O ₄ (tetroxide) | |
| | | | +5 | BiO ₃ ⁻ (metabismuthite) Bi ₂ O ₅ (pentoxide) | |
| | | | | | |
| | B | Vanadium (V) | +5 | VO ₂ ⁺ (vanadic) H ₃ V ₂ O ₇ ⁻ (pyrovanadate) H ₂ VO ₄ ⁻ (orthovanadate) VO ₃ ⁻ (metavanadate) HVO ₄ ⁻² (orthovanadate) VO ₄ ⁻³ (orthovanadate) V ₂ O ₅ (pentoxide) H ₄ V ₂ O ₇ (pyrovanadic acid) HVO ₃ (metavanadic acid) H ₄ V ₆ O ₁₇ (hexavanadic acid) | +5 Species/ +7, +9 Species |
| | | | +7 | VO ₄ ⁻ (pervanadate) | |
| | | | +9 | VO ₅ ⁻ (hypervanadate) | |
| | | | | | |
| | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES | | |
|----------------|-------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| V | B | Niobium (Nb) | +5 | NbO ₃ ⁻ (metaniobate) NbO ₄ ⁻³ (orthoniobate) Nb ₂ O ₅ (pentoxide) HNbO ₃ (niobid acid) | +5 Species/ +7 species | | |
| | | | +7 | NbO ₄ ⁻ (perniobate) Nb ₂ O ₇ (perniobic oxide) HNbO ₄ (perniobic acid) | | | |
| | | | Tantalum (Ta) | +5 | | TaO ₃ ⁻ (metatantalate) TaO ₄ ⁻³ (orthotantalate) Ta ₂ O ₅ (pentoxide) HTaO ₃ (tantalic acid) | +5 species/ +7 species |
| | | | | +7 | | TaO ₄ ⁻ (pentantalate) Ta ₂ O ₇ (pertantalate) HTaO ₄ •H ₂ O (pertantalic acid) | |
| | | VI | A | Sulfur (S) | +6 | H ₂ SO ₄ (sulfuric acid) HSO ₄ ⁻ (bisulfate) SO ₄ ⁻² (sulfate) | +6 Species/ +7, +8 Species |
| | | | | | +7 | S ₂ O ₈ ⁻² (dipersulfate) | |
| +8 | H ₂ SO ₅ (momopersulfuric acid) | | | | | | |
| Selenium (Se) | +6 | | | | H ₂ Se ₂ O ₄ (selenic acid) HSeO ₄ ⁻ (biselenate) SeO ₄ ⁻² (selenate) | +6 species/ +7 Species | |
| | +7 | | | H ₂ Se ₂ O ₈ (perdiselenic acid) | | | |
| Tellurium (Te) | +6 | | | H ₂ TeO ₄ (telluric acid) HTeO ₄ ⁻ (bitellurate) TeO ₄ ⁻² (tellurate) | +6 species/ +7 species | | |
| | +7 | H ₂ Te ₂ O ₈ (perditellenic acid) | | | | | |
| | Polonium (Po) | +2 | Po ⁺² (polonous) | +2, +4 species/ +6 Species | | | |
| | | +4 | PoO ₃ ⁻² (polonate) | | | | |
| +6 | | PoO ₃ (peroxide) | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-----------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VI | B | Chromium | +3 | Cr^{+3} (chromic) CrOH^{+2} , $\text{Cr}(\text{OH})_2^+$ (chromyls) CrO_2^- , CrO_3^{-3} (chromites) Cr_2O_3 (chromic oxide) $\text{Cr}(\text{OH})_3$ (chromic hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | CrO_2 (dioxide) $\text{Cr}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | H_2CrO_4 (chromic acid) HCrO_4^- (acid chromate) CrO_4^{-2} (chromate) $\text{Cr}_2\text{O}_7^{-2}$ (dichromate) | |
| | | Molybdenum (Mo) | +6 | HMoO_4^- (bimolybdate) MoO_4^{-2} (molybdate) MoO_3 (molybdic trioxide) H_2MoO_4 (molybolic acid) | +6 Species/ +7 Species |
| | | | +7 | MoO_4^- (permolybdate) | |
| | | Tungsten (W) | +6 | WO_4^{-2} tungstic) WO_3 (trioxide) H_2WO_4 (tungstic acid) | +6 Species/ +8 Species |
| | | | +8 | WO_5^{-2} (pertungstic) H_2WO_5 (pertungstic acid) | |
| | | Chlorine (Cl) | -1 | Cl^- (chloride) | -1 Species/ +1, +3, +5, +7 Species |
| | | | +1 | HClO (hypochlorous acid) ClO^- (hypochlorite) | +1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species; +5 Species/ +7 Species |
| | | | +3 | HClO_2 (chlorous acid) ClO_2^- (chlorite) | |
| | | | +5 | HClO_3 (chloric acid) ClO_3^- (chlorate) | |
| | | | +7 | HClO_4 (perchloric acid) ClO_4^- , HClO_5^{-2} , ClO_5^{-3} , $\text{Cl}_2\text{O}_9^{-4}$ (perchlorates) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| VII | A | Bromine (Br) | -1 | Br^- (bromide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HBrO (hypobromous acid) BrO^- (hypobromite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HBrO_2 (bromous acid) BrO_2^- (bromite) | +5 Species/ +7 Species |
| | | | +5 | HBrO_3 (bromic acid) BrO_3^- (bromate) | |
| | | | +7 | HBrO_4 (perbromic acid) BrO_4^- , HBrO_5^{-2} , BrO_5^{-3} , $\text{Br}_2\text{O}_9^{-4}$ (prebromates) | |
| | | Iodine | -1 | I^- (iodide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HIO (hypoiodous acid) IO^- (hypoiodite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HIO_2 (iodous acid) IO_2^- (iodite) | +5 Species/ +7 Species |
| | | | +5 | HIO_3 (iodic acid) IO_3^- (iodate) | |
| | | | +7 | HIO_4 (periodic acid) IO_4^- , HIO_5^{-2} , IO_5^{-3} , $\text{I}_2\text{O}_9^{-4}$ (periodates) | |
| | B | Manganese (Mn) | +2 | Mn^{+2} (manganeous) HMnO_2^- (dimanganite) | +2 Species/ +3, +4, +6, +7 Species; +3 Species/ +4, +6, +7 Species; |
| | | | +3 | Mn^{+3} (manganic) | +4 Species/ +6, +7 Species; |
| | | | +4 | MnO_2 (dioxide) | +6 Species/ +7 Species |
| | | | +6 | MnO_4^{2-} (manganate) | |
| | | | +7 | MnO_4^- (permanganate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VIII | Period 4 | Iron (Fe) | +2 | Fe^{+2} (ferrous) HFeO_2 (dihypoferrite) | +2 Species/+3, +4, +5, +6 Species; |
| VIII | Period 4 | Iron (Fe) | +3 | Fe^{+3} (ferric) $\text{Fe}(\text{OH})^{+2}$ $\text{Fe}(\text{OH})_2^+$ FeO_2^{-2} (ferrite) | +3 Species/+4, +5, +6 Species; |
| | | | +4 | FeO^{+2} (ferryl) FeO_2^{-2} (perferrite) | +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +5 | FeO_2^+ (perferryl) | |
| | | | +6 | FeO_4^{-2} (ferrate) | |
| | | Cobalt (Co) | +2 | Co^{+2} (cobalous) HCoO_2^- (dicobaltite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Co^{+3} (cobaltic) Co_2O_3 (cobaltic oxide) | |
| | | | +4 | CoO_2 (peroxide) H_2CoO_3 (cobaltic acid) | |
| | | Nickel (Ni) | +2 | Ni^{+2} (nickelous) NiOH^+ HNiO_2^- (dinickelite) NiO_2^{-2} (nickelite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Ni^{+3} (nickelic) Ni_2O_3 (nickelic oxide) | |
| | | | +4 | NiO_2 (peroxide) | |
| | | | +6 | NiO_4^{-2} (nickelate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| VIII | Period 5 | Ruthenium (Ru) | +2 | Ru^{+2} | +2 Species/ +3, +4, +5, +6, +7, +8 Species; |
| | | | +3 | Ru^{+3} Ru_2O_3 (sesquioxide) $\text{Ru}(\text{OH})_3$ (hydroxide) | +3 Species/ +4, +5, +6, +7, +8 Species; +4 Species/ +5, +6, +7, +8 Species; +5 Species/ +6, +7, +8 Species; |
| | | | +4 | Ru^{+4} (ruthenic) RuO_2 (ruthenic dioxide) $\text{Ru}(\text{OH})_4$ (ruthenic hydroxide) | +6 Species/ +7, +8 Species; +7 Species/ +8 Species |
| | | | +5 | Ru_2O_5 (pentoxide) | |
| | | | +6 | RuO_4^{-2} (ruthenate) RuO_2^{+2} (ruthenyl) RuO_3 (trioxide) | |
| | | | +7 | RuO_4^- (perruthenate) | |
| | | | +8 | H_2RuO_4 (hyperuthenic acid) HRuO_5^- (diperruthenate) RuO_4 (ruthenium tetroxide) | |
| | | Rhodium (Rh) | +1 | Rh^+ (hyporhodous) | +1 Species/ +2, +3, +4, +6 Species; |
| | | | +2 | Rh^{+2} (rhodous) | +2 Species/ +3, +4, +6 Species; |
| | | | +3 | Rh^{+3} (rhodic) Rh_2O_3 (sesquioxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | RhO_2 (rhodic oxide) $\text{Rh}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | RhO_4^{-2} (rhodate) RhO_3 (trioxide) | |
| | | Palladium | +2 | Pd^{+2} (palladous) PdO_2^{-2} (palladite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; |
| | | | +3 | Pd_2O_3 (sesquioxide) | +4 Species/ +6 Species |
| | | | +4 | Pd O_3^{-2} (palladate) PdO_2 (dioxide) $\text{Pd}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | PdO_3 (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-------------|-------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| VIII | Period 6 | Iridium (Ir) | +3 | Ir ⁺³ (iridic) Ir ₂ O ₃ (iridium sesquioxide) Ir (OH) ₃ (iridium hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | IrO ₂ (iridic oxide) Ir (OH) ₄ (iridic hydroxide) | |
| | | | +6 | IrO ₄ ⁻² (iridate) IrO ₃ (iridium peroxide) | |
| | | Platinum (Pt) | +2 | Pt ⁺² (platinous) | +2, +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Pt ₂ O ₃ (sesquioxide) | |
| | | | +4 | PtO ₃ ⁻² (palatinate) PtO ⁺² (platynyl) Pt(OH) ⁺³ PtO ₂ (platinic oxide) | |
| IIIB | Rare earths | Cerium (Ce) | +3 | Ce ⁺³ (cerous) Ce ₂ O ₃ (cerous oxide) Ce(OH) ₃ (cerous hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | Ce ⁺⁴ , Ce(OH) ⁺³ , Ce(OH) ₂ ⁺² , Ce(OH) ₃ ⁺¹ (ceric) CeO ₂ (ceric oxide) | |
| | | | +6 | CeO ₃ (peroxide) | |
| | | Praseodymium (Pr) | +3 | Pr ⁺³ (praseodymous) Pr ₂ O ₃ (sesquioxide) Pr(OH) ₃ (hydroxide) | +3 species/ +4 species |
| | | | +4 | Pr ⁺⁴ (praseodymic) PrO ₂ (dioxide) | |
| | | Neodymium | +3 | Nd ⁺³ Nd ₂ O ₃ (sesquioxide) | +3 Species/ +4 Species |
| | | | +4 | NdO ₂ (peroxide) | |
| | | Terbium (Tb) | +3 | Tb ⁺³ Tb ₂ O ₃ (sesquioxide) | +3 Species/ +4 Species |
| | | | +4 | TbO ₂ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| IIIB | Actinides | Thorium (Th) | +4 | Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate) | +4 Species/ +6 Species |
| | | | +6 | ThO ₃ (acid peroxide) | |
| | | Uranium (U) | +6 | UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide) | +6 Species/ +8 Species |
| | | | +8 | HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide) | |
| | | Neptunium (Np) | +5 | NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide) | +5 Species/ +6, +8 Species; +6 Species/ +8 Species |
| | | | +6 | NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide) | |
| | | | +8 | NpO ₄ (peroxide) | |
| | | Plutonium (Pu) | +3 | Pu ⁺³ (hypoplutinous) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Pu ⁺⁴ (plutinous) PuO ₂ (dioxide) | |
| | | | +5 | PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide) | |
| | | | +6 | PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide) | |
| | | Americium (Am) | +3 | Am ⁺³ (hypoamericious) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₄ (hydroxide) | |
| | | | +5 | AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide) | |
| | | | +6 | AmO ₂ ⁺² (americyl) AmO ₃ (peroxide) | |

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

| GROUP | SUB GROUP | ELEMENT |
|-------|-------------|-------------------------------------------------------------------------------|
| I | A | Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs) |
| | B | Copper (Cu), Silver (Ag), and Gold (Au) |
| II | A | Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba) |
| | B | Zinc (Zn), Cadmium (Cd), and Mercury (Hg) |
| III | A | Boron (B), and Aluminum (Al) |
| | B | Scandium (Sc), and Yttrium (Y) – (See Rare Earths) |
| IV | A | Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb) |
| | B | Titanium (Ti), Zirconium (Zr), and Hafnium (Hf) |
| V | A | Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi) |
| | B | Vanadium (V), Niobium (Nb), and Tantalum (Ta) |
| VI | A | Sulfur (S), Selenium (Se), and Tellurium (Te) |
| | B | Chromium (Cr), Molybdenum (Mo), and Tungsten (W) |
| VII | A | Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I) |
| | B | Manganese (Mn), Technetium (Tc), and Rhenium (Re) |
| VIII | Period 4 | Iron (Fe), Cobalt (Co), and Nickel (Ni) |
| | Period 5 | Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd) |
| | Period 6 | Osmium (Os), Iridium (Ir), and Platinum (Pt) |
| IIIB | Rare Earths | All |

further comprising adding stabilizing compounds to the electrolyte for overcoming and stabilizing the short lifetime of oxidized forms of higher oxidation state species of the mediator, wherein the stabilizing compounds are tellurate or periodate ions.

96. (Previously presented) A process for treating and oxidizing Sharps I and sterilizing Sharps II and waste materials comprising disposing an electrolyte in an electrochemical cell, separating the electrolyte into an anolyte portion and a catholyte portion with an ion-selective membrane, semipermeable membrane, microporous polymer, porous ceramic, or glass frit, applying a direct current voltage between the anolyte portion and the catholyte portion, placing the sharps and waste in the anolyte portion, and oxidizing the Sharps I into metallic ions in solution in the anolyte, sterilizing Sharps II, and waste in the anolyte portion with a mediated electrochemical oxidation (MEO) process, wherein the anolyte portion further comprises oxidizing species as a mediator in aqueous solution and the

electrolyte is an acid, neutral or alkaline aqueous solution, and wherein the mediator oxidizing species are selected from the group consisting of (a.) simple ion redox couples described in Table I as below; (b.) Type I isopolyanions complex anion redox couples formed by incorporation of elements in Table I, or mixtures thereof as addenda atoms; (c.) Type I heteropolyanions complex anion redox couples formed by incorporation into Type I isopolyanions as heteroatoms any element selected from the group consisting of the elements listed in Table II either singly or in combination thereof, or (d.) heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or (e.) combinations of the mediator oxidizing species from any or all of (a.), (b.), (c.), and (d.)

Table I: Simple Ion Redox Couples

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| I | A | None | | | |
| | B | Copper (Cu) | +2 | Cu ⁺² (cupric) HCuO ₂ (bicuprite) CuO ₂ ⁻² (cuprite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Cu ⁺³ CuO ₂ ⁻ (cuprate) Cu ₂ O ₃ (sesquioxide) | |
| | | | +4 | CuO ₂ (peroxide) | |
| | | Silver (Ag) | +1 | Ag ⁺ (argentous) AgO ⁻ (argentite) | +1 Species/ +2, +3 Species; +2 Species/ +3 Species |
| | | | +2 | Ag ⁺² (argentic) AgO (argentic oxide) | |
| | | | +3 | AgO ⁺ (argentlyl) Ag ₂ O ₃ (sesquioxide) | |
| | | Gold (Au) | +1 | Au ⁺ (aurous) | +1 Species/ +3, +4 Species; + 3 Species/ +4 Species |
| | | | +3 | Au ⁺³ (auric) AuO ⁻ (auryl) H ₃ AuO ₃ ⁻ (auric acid) H ₂ AuO ₃ ⁻ (monoaurate) HAuO ₃ ⁻² (diaurate) AuO ₃ ⁻³ (triaurate) Au ₂ O ₃ (auric oxide) Au(OH) ₃ (auric hydroxide) | |
| | | | +4 | AuO ₂ (peroxide) | |
| | | | | | |
| II | A | Magnesium (Mg) | +2 | Mg ⁺² (magnestic) | +2 Species/ +4 Species |
| | | | +4 | MgO ₂ (peroxide) | |

| | | | | | |
|--|--|--------------|----|---------------------------|------------------------|
| | | Calcium (Ca) | +2 | Ca^{+2} | +2 Species/ +4 Species |
| | | | +4 | CaO_2 (peroxide) | |
| | | Strontium | +2 | Sr^{+2} | +2 Species/ +4 Species |
| | | | +4 | SrO_2 (peroxide) | |
| | | Barium (Ba) | +2 | Ba^{+2} | +2 Species/ +4 Species |
| | | | +4 | BaO_2 (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|---------------|---------|--------------------------------------------------------------------------------------------|------------------------------------------------------------|
| II | B | Zinc (Zn) | +2 | Zn^{+2} (zincic) | +2 Species/ +4 Species |
| | | | | ZnOH^+ (zincyl) HZnO_2^- (bizincate) ZnO_2^{-2} (zincate) | |
| | | | | +4 ZnO_2 (peroxide) | |
| | | Mercury (Hg) | +2 | Hg^{+2} (mercuric) | +2 Species/ +4 Species |
| | | | | $\text{Hg}(\text{OH})_2$ (mercuric hydroxide) HHgO_2^- (mercuroate) | |
| III | A | Boron | +3 | H_3BO_3 (orthoboric acid) | +3 Species/ +4.5, +5 Species |
| | | | | H_2BO_3^- , HBO_3^{-2} , BO_3^{-3} (orthoborates) | |
| | | | | BO_2^- (metaborate) | |
| | | | | $\text{H}_2\text{B}_4\text{O}_7$ (tetraboric acid) | |
| | | | | $\text{HB}_4\text{O}_7^-/\text{B}_4\text{O}_7^{-2}$ (tetraborates) | |
| | | | | $\text{B}_2\text{O}_4^{-2}$ (diborate) | |
| | | Thallium (Tl) | +1 | Ti^{+1} (thallous) | +1 Species/ +3 or +3.33 Species; +3 Species/ +3.33 Species |
| | | | | Ti^{+3} (thallic) | |
| | | | | TlO^+ , TlOH^{+2} , $\text{Tl}(\text{OH})_2^+$ (thallyl) | |
| | | | | Ti_2O_3 (sesquioxide) $\text{Ti}(\text{OH})_3$ (hydroxide) | |
| | | | +3.33 | Ti_3O_5 (peroxide) | |
| | | | | | |
| | | B | | See Rare Earths and Actinides | |
| | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| IV | A | Carbon (C) | +4 | H ₂ CO ₃ (carbonic acid) HCO ₃ ⁻ (bicarbonate) CO ₃ ⁻² (carbonate) | +4 Species/ +5, +6 Species |
| | | | +5 | H ₂ C ₂ O ₆ (perdicarbonic acid) | |
| | | | +6 | H ₂ CO ₄ (permonocarbonic acid) | |
| | | Germanium (Ge) | +4 | H ₂ GeO ₃ (germanic acid) HGeO ₃ ⁻ (bigermaniate) GeO ₃ ⁻⁴ (germinate) Ge ⁺⁴ (germanic) GeO ₄ ⁻⁴ H ₂ Ge ₂ O ₅ (digermanic acid) H ₂ Ge ₄ O ₉ (tetragermanic acid) H ₂ Ge ₅ O ₁₁ (pentagermanic acid) HGe ₅ O ₁₁ ⁻ (bipentagermanate) | +4 Species/ +6 Species |
| | | | +6 | Ge ₅ O ₁₁ ⁻² (pentagemanate) | |
| | | Tin (Sn) | +4 | Sn ⁺⁴ (stannic) HSnO ₃ ⁻ (bistannate) SnO ₃ ⁻² (stannate) SnO ₂ (stannic oxide) Sn(OH) ₄ (stannic hydroxide) | +4 Species/ +7 Species |
| | | | +7 | SnO ₄ ⁻ (perstannate) | |
| | | Lead (Pb) | +2 | Pb ⁺² (plumbous) HPbO ₂ ⁻ (biplumbite) PbOH ⁺ PbO ₂ ⁻² (plumbite) PbO (plumbus oxide) | +2, +2.67, +3 Species/+4 Species |
| | | | | Pb ₃ O ₄ (plumbo-plumbic oxide) | |
| | | | +2.67 | Pb ₃ O ₄ (plumbo-plumbic oxide) | |
| | | | +3 | Pb ₂ O ₃ (sequioxide) | |
| | | | +4 | Pb ⁺⁴ (plumbic) | |
| IV | A | Lead (Pb) | | PbO ₃ ⁻² (metaplumbate) HPbO ₃ ⁻ (acid metaplumbate) PbO ₄ ⁻⁴ (orthoplumbate) PbO ₂ (dioxide) | +2, +2.67, +3 Species/+4 Species |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| IV | B | Titanium | +4 | TiO ²⁺ (pertitanyl) HTiO ₄ ⁻ (titanate) TiO ₂ (dioxide) | +4 Species/ +6 Species |
| | | | +6 | TiO ₂ ²⁺ (pertitanyl) HTiO ₄ ⁻ (acid pertitanate) TiO ₄ ⁻² (pertitanate) TiO ₃ (peroxide) | |
| | | Zirconium (Zr) | +4 | Zr ⁴⁺ (zirconic) ZrO ²⁺ (zirconyl) HZrO ₃ ⁻ (zirconate) | +4 Species/ +5, +6, +7 Species |
| | | | +5 | Zr ₂ O ₅ (pentoxide) | |
| | | | +6 | ZrO ₃ (peroxide) | |
| | | | +7 | Zr ₂ O ₇ (heptoxide) | |
| | | Hafnium (Hf) | +4 | Hf ⁴⁺ (hafnic) HfO ²⁺ (hafnyl) | +4 Species/ +6 Species |
| | | | +6 | HfO ₃ (peroxide) | |
| V | A | Nitrogen | +5 | HNO ₃ (nitric acid) NO ₃ ⁻ (nitrate) | +5 species/ +7 Species |
| | | | +7 | HNO ₄ (pernitric acid) | |
| | | Phosphorus (P) | +5 | H ₃ PO ₄ (orthophosphoric acid) H ₂ PO ₄ ⁻ (monoorthophosphate) HPO ₄ ⁻² (diorthophosphate) PO ₄ ⁻³ (triorthophosphate) HPO ₃ (metaphosphoric acid) H ₄ P ₂ O ₇ (pyrophosphoric acid) H ₅ P ₃ O ₁₀ (triphosphoric acid) H ₆ P ₄ O ₁₃ (tetrphosphoric acid) | +5 Species/ +6, +7 species |
| | | | | | |
| V | A | Phosphorus (P) | +6 | H ₄ P ₂ O ₈ (perphosphoric acid) | +5 Species/ +6, +7 Species |
| | | | +7 | H ₃ PO ₅ (monoperphosphoric acid) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| V | A | Arsenic (As) | +5 | H ₃ AsO ₄ (ortho-arsenic acid) H ₂ AsO ₄ ⁻ (mono ortho-arsenate) HAsO ₄ ⁻² (di-ortho-arsenate) AsO ₄ ⁻³ (tri-ortho-arsenate) AsO ₂ ⁺ (arsenyl) | +5 Species/ +7 species |
| | | | +7 | AsO ₃ ⁺ (perarsenyl) | |
| | | Bismuth (Bi) | +3 | Bi ⁺³ (bismuthous) BiOH ⁺² (hydroxybismuthous) BiO ⁺ (bismuthyl) BiO ₂ ⁻ (metabismuthite) | +3 Species/ +3.5, +4, +5 Species |
| | | | +3.5 | Bi ₄ O ₇ (oxide) | |
| | | | +4 | Bi ₂ O ₄ (tetroxide) | |
| | | | +5 | BiO ₃ ⁻ (metabismuthite) Bi ₂ O ₅ (pentoxide) | |
| | | | | | |
| | B | Vanadium (V) | +5 | VO ₂ ⁺ (vanadic) H ₃ V ₂ O ₇ ⁻ (pyrovanadate) H ₂ VO ₄ ⁻ (orthovanadate) VO ₃ ⁻ (metavanadate) HVO ₄ ⁻² (orthovanadate) VO ₄ ⁻³ (orthovanadate) V ₂ O ₅ (pentoxide) H ₄ V ₂ O ₇ (pyrovanadic acid) HVO ₃ (metavanadic acid) H ₄ V ₆ O ₁₇ (hexavanadic acid) | +5 Species/ +7, +9 Species |
| | | | +7 | VO ₄ ⁻ (pervanadate) | |
| | | | +9 | VO ₅ ⁻ (hypervanadate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES | | |
|----------------|-------------------------------------------------------------------|--------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| V | B | Niobium (Nb) | +5 | NbO ₃ ⁻ (metaniobate) NbO ₄ ⁻³ (orthoniobate) Nb ₂ O ₅ (pentoxide) HNbO ₃ (niobid acid) | +5 Species/ +7 species | | |
| | | | +7 | NbO ₄ ⁻ (perniobate) Nb ₂ O ₇ (perniobic oxide) HNbO ₄ (perniobic acid) | | | |
| | | | Tantalum (Ta) | +5 | | TaO ₃ ⁻ (metatantalate) TaO ₄ ⁻³ (orthotanatalate) Ta ₂ O ₅ (pentoxide) HTaO ₃ (tantalic acid) | +5 species/ +7 species |
| | | | | +7 | | TaO ₄ ⁻ (pentantalate) Ta ₂ O ₇ (pertantalate) HTaO ₄ •H ₂ O (pertantalic acid) | |
| | | VI | A | Sulfur (S) | +6 | H ₂ SO ₄ (sulfuric acid) HSO ₄ ⁻ (bisulfate) SO ₄ ⁻² (sulfate) | +6 Species/ +7, +8 Species |
| | | | | | +7 | S ₂ O ₈ ⁻² (dipersulfate) | |
| | | | | | +8 | H ₂ SO ₅ (momopersulfuric acid) | |
| | | | | | Selenium (Se) | +6 | |
| +7 | H ₂ Se ₂ O ₈ (perdiselenic acid) | | | | | | |
| Tellurium (Te) | +6 | | | H ₂ TeO ₄ (telluric acid) HTeO ₄ ⁻ (bitellurate) TeO ₄ ⁻² (tellurate) | | +6 species/ +7 species | |
| | +7 | | | H ₂ Te ₂ O ₈ (perditellenic acid) | | | |
| | Polonium (Po) | | | +2 | Po ⁺² (polonous) | | +2, +4 species/ +6 Species |
| +4 | | | | PoO ₃ ⁻² (polonate) | | | |
| +6 | | | | PoO ₃ (peroxide) | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| VI | B | Chromium | +3 | Cr ⁺³ (chromic) CrOH ⁺² , Cr(OH) ₂ ⁺ (chromyls) CrO ₂ ⁺ , CrO ₃ ⁻³ (chromites) Cr ₂ O ₃ (chromic oxide) Cr(OH) ₃ (chromic hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | CrO ₂ (dioxide) Cr(OH) ₄ (hydroxide) | |
| | | | +6 | H ₂ CrO ₄ (chromic acid) HCrO ₄ ⁻ (acid chromate) CrO ₄ ⁻² (chromate) Cr ₂ O ₇ ⁻² (dichromate) | |
| | | Molybdenum (Mo) | +6 | HMoO ₄ ⁻ (bimolybdate) MoO ₄ ⁻² (molybdate) MoO ₃ (molybdic trioxide) H ₂ MoO ₄ (molybolic acid) | +6 Species/ +7 Species |
| | | | +7 | MoO ₄ ⁻ (permolybdate) | |
| | | Tungsten (W) | +6 | WO ₄ ⁻² tungstic) WO ₃ (trioxide) H ₂ WO ₄ (tungstic acid) | +6 Species/ +8 Species |
| | | | +8 | WO ₅ ⁻² (pertungstic) H ₂ WO ₅ (pertungstic acid) | |
| | | Chlorine (Cl) | -1 | Cl ⁻ (chloride) | -1 Species/ +1, +3, +5, +7 Species |
| | | | +1 | HClO (hypochlorous acid) ClO ⁻ (hypochlorite) | +1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HClO ₂ (chlorous acid) ClO ₂ ⁻ (chlorite) | +5 Species/ +7 Species |
| | | | +5 | HClO ₃ (chloric acid) ClO ₃ ⁻ (chlorate) | |
| | | | +7 | HClO ₄ (perchloric acid) ClO ₄ ⁻ , HClO ₅ ⁻² , ClO ₅ ⁻³ , Cl ₂ O ₉ ⁻⁴ (perchlorates) | |
| VII | A | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| VII | A | Bromine (Br) | -1 | Br ⁻ (bromide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HBrO (hypobromous acid) BrO ⁻ (hypobromite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HBrO ₂ (bromous acid) BrO ₂ ⁻ (bromite) | +5 Species/ +7 Species |
| | | | +5 | HBrO ₃ (bromic acid) BrO ₃ ⁻ (bromate) | |
| | | | +7 | HBrO ₄ (perbromic acid) BrO ₄ ⁻ , HBrO ₅ ⁻² , BrO ₅ ⁻³ , Br ₂ O ₉ ⁻⁴ (prebromates) | |
| | | Iodine | -1 | I ⁻ (iodide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HIO (hypoiodous acid) IO ⁻ (hypoiodite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HIO ₂ (iodous acid) IO ₂ ⁻ (iodite) | +5 Species/ +7 Species |
| | | | +5 | HIO ₃ (iodic acid) IO ₃ ⁻ (iodate) | |
| | | | +7 | HIO ₄ (periodic acid) IO ₄ ⁻ , HIO ₅ ⁻² , IO ₅ ⁻³ , I ₂ O ₉ ⁻⁴ (periodates) | |
| | B | Manganese (Mn) | +2 | Mn ⁺² (manganeous) HMnO ₂ ⁻ (dimanganite) | +2 Species/ +3, +4, +6, +7 Species; +3 Species/ +4, +6, +7 Species; |
| | | | +3 | Mn ⁺³ (manganic) | +4 Species/ +6, +7 Species; |
| | | | +4 | MnO ₂ (dioxide) | +6 Species/ +7 Species |
| | | | +6 | MnO ₄ ⁻² (manganate) | |
| | | | +7 | MnO ₄ ⁻ (permanganate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VIII | Period 4 | Iron (Fe) | +2 | Fe^{+2} (ferrous) HFeO_2 (dihypoferrite) | +2 Species/+3, +4, +5, +6 Species; |
| | | | +3 | Fe^{+3} (ferric) $\text{Fe}(\text{OH})^{+2}$ $\text{Fe}(\text{OH})_2^+$ FeO_2^{-2} (ferrite) | +3 Species/+4, +5, +6 Species; |
| | Period 4 | Iron (Fe) | +4 | FeO^{+2} (ferryl) FeO_2^{-2} (perferrite) | +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +5 | FeO_2^+ (perferryl) | |
| | | | +6 | FeO_4^{-2} (ferrate) | |
| | | Cobalt (Co) | +2 | Co^{+2} (cobalous) HCoO_2^- (dicobaltite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Co^{+3} (cobaltic) Co_2O_3 (cobaltic oxide) | |
| | | | +4 | CoO_2 (peroxide) H_2CoO_3 (cobaltic acid) | |
| | | Nickel (Ni) | +2 | Ni^{+2} (nickelous) NiOH^+ HNiO_2^- (dinickelite) NiO_2^{-2} (nickelite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Ni^{+3} (nickelic) Ni_2O_3 (nickelic oxide) | |
| | | | +4 | NiO_2 (peroxide) | |
| | | | +6 | NiO_4^{-2} (nickelate) | |
| | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| VIII | Period 5 | Ruthenium (Ru) | +2 | Ru^{+2} | +2 Species/ +3, +4, +5, +6, +7, +8 Species; |
| | | | +3 | Ru^{+3} Ru_2O_3 (sesquioxide) $\text{Ru}(\text{OH})_3$ (hydroxide) | +3 Species/ +4, +5, +6, +7, +8 Species; +4 Species/ +5, +6, +7, +8 Species; +5 Species/ +6, +7, +8 Species; |
| | | | +4 | Ru^{+4} (ruthenic) RuO_2 (ruthenic dioxide) $\text{Ru}(\text{OH})_4$ (ruthenic hydroxide) | +6 Species/ +7, +8 Species; +7 Species/ +8 Species |
| | | | +5 | Ru_2O_5 (pentoxide) | |
| | | | +6 | RuO_4^{-2} (ruthenate) RuO_2^{+2} (ruthenyl) RuO_3 (trioxide) | |
| | | | +7 | RuO_4^- (perruthenate) | |
| | | | +8 | H_2RuO_4 (hyperuthenic acid) HRuO_5^- (diperruthenate) RuO_4 (ruthenium tetroxide) | |
| | | Rhodium (Rh) | +1 | Rh^+ (hyporhodous) | +1 Species/ +2, +3, +4, +6 Species; |
| | | | +2 | Rh^{+2} (rhodous) | +2 Species/ +3, +4, +6 Species; |
| | | | +3 | Rh^{+3} (rhodic) Rh_2O_3 (sesquioxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | RhO_2 (rhodic oxide) $\text{Rh}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | RhO_4^{-2} (rhodate) RhO_3 (trioxide) | |
| | | Palladium | +2 | Pd^{+2} (palladous) PdO_2^{-2} (palladite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; |
| | | | +3 | Pd_2O_3 (sesquioxide) | +4 Species/ +6 Species |
| | | | +4 | Pd O_3^{-2} (palladate) PdO_2 (dioxide) $\text{Pd}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | PdO_3 (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-------------|-------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| VIII | Period 6 | Iridium (Ir) | +3 | Ir ⁺³ (iridic) Ir ₂ O ₃ (iridium sesquioxide) Ir (OH) ₃ (iridium hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | | IrO ₂ (iridic oxide) Ir (OH) ₄ (iridic hydroxide) | |
| | | | | IrO ₄ ⁻² (iridate) IrO ₃ (iridium peroxide) | |
| | | Platinum (Pt) | +2 | Pt ⁺² (platinous) | +2, +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Pt ₂ O ₃ (sesquioxide) | |
| | | | +4 | PtO ₃ ⁻² (palatinate) PtO ⁺² (platynyl) Pt(OH) ⁺³ PtO ₂ (platinic oxide) | |
| IIIB | Rare earths | Cerium (Ce) | +3 | Ce ⁺³ (cerous) Ce ₂ O ₃ (cerous oxide) Ce(OH) ₃ (cerous hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | | Ce ⁺⁴ , Ce(OH) ⁺³ , Ce(OH) ₂ ⁺² , Ce(OH) ₃ ⁺ (ceric) CeO ₂ (ceric oxide) | |
| | | | | CeO ₃ (peroxide) | |
| | | Praseodymium (Pr) | +3 | Pr ⁺³ (praseodymous) Pr ₂ O ₃ (sesquioxide) Pr(OH) ₃ (hydroxide) | +3 species/ +4 species |
| | | | +4 | Pr ⁺⁴ (praseodymic) PrO ₂ (dioxide) | |
| | | | | | |
| | | Neodymium | +3 | Nd ⁺³ Nd ₂ O ₃ (sesquioxide) | +3 Species/ +4 Species |
| | | | | NdO ₂ (peroxide) | |
| | | | +4 | | |
| | | Terbium (Tb) | +3 | Tb ⁺³ Tb ₂ O ₃ (sesquioxide) | +3 Species/ +4 Species |
| | | | | TbO ₂ (peroxide) | |
| | | | +4 | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| IIIB | Actinides | Thorium (Th) | +4 | Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate) | +4 Species/ +6 Species |
| | | | +6 | ThO ₃ (acid peroxide) | |
| | | Uranium (U) | +6 | UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide) | +6 Species/ +8 Species |
| | | | +8 | HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide) | |
| | | Neptunium (Np) | +5 | NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide) | +5 Species/ +6, +8 Species; +6 Species/ +8 Species |
| | | | +6 | NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide) | |
| | | | +8 | NpO ₄ (peroxide) | |
| | | Plutonium (Pu) | +3 | Pu ⁺³ (hypoplutinous) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Pu ⁺⁴ (plutinous) PuO ₂ (dioxide) | |
| | | | +5 | PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide) | |
| | | | +6 | PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide) | |
| | | Americium (Am) | +3 | Am ⁺³ (hypoamericious) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₄ (hydroxide) | |
| | | | +5 | AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide) | |
| | | | +6 | AmO ₂ ⁺² (americyl) AmO ₃ (peroxide) | |
| | | | | | |

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

| GROUP | SUB GROUP | ELEMENT |
|-------|-------------|-------------------------------------------------------------------------------|
| I | A | Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs) |
| | B | Copper (Cu), Silver (Ag), and Gold (Au) |
| II | A | Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba) |
| | B | Zinc (Zn), Cadmium (Cd), and Mercury (Hg) |
| III | A | Boron (B), and Aluminum (Al) |
| | B | Scandium (Sc), and Yttrium (Y) – (See Rare Earths) |
| IV | A | Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb) |
| | B | Titanium (Ti), Zirconium (Zr), and Hafnium (Hf) |
| V | A | Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi) |
| | B | Vanadium (V), Niobium (Nb), and Tantalum (Ta) |
| VI | A | Sulfur (S), Selenium (Se), and Tellurium (Te) |
| | B | Chromium (Cr), Molybdenum (Mo), and Tungsten (W) |
| VII | A | Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I) |
| | B | Manganese (Mn), Technetium (Tc), and Rhenium (Re) |
| VIII | Period 4 | Iron (Fe), Cobalt (Co), and Nickel (Ni) |
| | Period 5 | Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd) |
| | Period 6 | Osmium (Os), Iridium (Ir), and Platinum (Pt) |
| IIIB | Rare Earths | All |

wherein the oxidizing agents are super oxidizers, and further comprising generating inorganic free radicals in aqueous solutions from carbonate, azide, nitrite, nitrate, phosphite, phosphate, sulfite, sulfate, selenite, thiocyanate, chloride, and formate oxidizing species, wherein the super oxidizers have an oxidation potential above a threshold value of 1.7 volts at 1 molar, 25°C and pH1.

97. (Previously presented) The system of claim 89, further comprising a membrane separating the anolyte portion and a catholyte portion of the electrolyte, wherein the membrane is an ion-selective membrane, or semi permeable membrane, microporous polymer membrane, porous ceramic membrane, or glass frit.

98. (Currently amended) Apparatus for treating and oxidizing Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials comprising an electrochemical cell, an aqueous electrolyte disposed in the electrochemical cell, a semi permeable membrane, ion selective membrane, microporous

membrane, porous ceramic or glass frit membrane disposed in the electrochemical cell for separating the cell into anolyte and catholyte chambers and separating the anolyte and catholyte portions, electrodes further comprising an anode and a cathode disposed in the electrochemical cell respectively in the anolyte and catholyte chambers and in the anolyte and catholyte portions of the electrolyte, a power supply connected to the anode and the cathode for applying a direct current voltage between the anolyte and the catholyte portions of the electrolyte, and oxidizing of the materials in the anolyte portion with a mediated electrochemical oxidation (MEO) process wherein the anolyte portion further comprises a mediator in aqueous solution for producing reversible redox couples used as oxidizing species and the electrolyte is an acid, neutral or alkaline aqueous solution, wherein the mediator oxidizing species are selected from the group consisting of (a.) simple ion redox couples described in Table I as below; (b.) Type I isopolyanions complex anion redox couples formed by incorporation of elements in Table I or mixtures thereof as addenda atoms; (c.) Type I heteropolyanions complex anion redox couples formed by incorporation into Type I isopolyanions as heteroatoms any element selected from the group consisting of the elements listed in Table II either singly or in combination thereof, or (d.) heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or (e.) combinations of the mediator oxidizing species from any or all of (a.), (b.), (c.), and (d.)

Table I: Simple Ion Redox Couples

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------|---------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| I | A | None | | | |
| | B | Copper (Cu) | +2 | Cu ⁺² (cupric) HCuO ₂ (bicuprite) CuO ₂ ⁻² (cuprite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Cu ⁺³ CuO ₂ ⁻ (cuprate) Cu ₂ O ₃ (sesquioxide) | |
| | | | +4 | CuO ₂ (peroxide) | |
| | | Silver (Ag) | +1 | Ag ⁺ (argentous) AgO ⁻ (argentite) | +1 Species/ +2, +3 Species; +2 Species/ +3 Species |
| | | | +2 | Ag ⁺² (argentic) AgO (argentic oxide) | |

| | | | | | |
|----|---|-------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| II | A | Gold (Au) | +3 | AgO ⁺ (argentyI) Ag ₂ O ₃ (sesquioxide) | +1 Species/ +3, +4 Species; + 3 Species/ +4 Species |
| | | | +1 | Au ⁺ (aurous) | |
| | | | +3 | Au ⁺³ (auric) AuO ⁻ (auryl) H ₃ AuO ₃ ⁻ (auric acid) H ₂ AuO ₃ ⁻ (monoaurate) HAuO ₃ ⁻² (diaurate) AuO ₃ ⁻³ (triaurate) Au ₂ O ₃ (auric oxide) Au(OH) ₃ (auric hydroxide) | |
| | | | +4 | AuO ₂ (peroxide) | |
| | | Magnesium (Mg) | +2 | Mg ⁺² (magnesian) | +2 Species/ +4 Species |
| | | | +4 | MgO ₂ (peroxide) | |
| | | Calcium (Ca) | +2 | Ca ⁺² | +2 Species/ +4 Species |
| | | | +4 | CaO ₂ (peroxide) | |
| | | Strontium | +2 | Sr ⁺² | +2 Species/ +4 Species |
| | | | +4 | SrO ₂ (peroxide) | |
| | | Barium (Ba) | +2 | Ba ⁺² | +2 Species/ +4 Species |
| | | | +4 | BaO ₂ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES | | |
|---------------|--------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------|---------------------------------------------------------------------------------------|---------------------------|
| II | B | Zinc (Zn) | +2 | Zn^{+2} (zincic) $ZnOH^+$ (zincyl) $HZnO_2^-$ (bizincate) ZnO_2^{-2} (zincate) | +2 Species/ +4 Species | | |
| | | | +4 | ZnO_2 (peroxide) | | | |
| | | | Mercury (Hg) | +2 | | Hg^{+2} (mercuric) $Hg(OH)_2$ (mercuric hydroxide) $HHgO_2^-$ (mercurate) | +2 Species/ +4 Species |
| | | +4 | | HgO_2 (peroxide) | | | |
| | | III | | A | Boron | +3 | |
| | | | +4.5 | | | $B_2O_5^-$ (diborate) | |
| +5 | $BO_3^-/BO_2 \cdot H_2O$ (perborate) | | | | | | |
| Thallium (Tl) | +1 | | Tl^{+1} (thallous) | | | +1 Species/ +3 or +3.33 Species; +3 Species/ +3.33 Species | |
| | +3 | | Tl^{+3} (thallic) TlO^+ , $TlOH^{+2}$, $Tl(OH)_2^+$ (thallyl) Tl_2O_3 (sesquioxide) $Tl(OH)_3$ (hydroxide) | | | | |
| | +3.33 | | Tl_3O_5 (peroxide) | | | | |
| | B | See Rare Earths and Actinides | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------|----------------------------------------|
| IV | A | Carbon (C) | +4 | H ₂ CO ₃ (carbonic acid) | +4 Species/ +5, +6 Species |
| | | | | HCO ₃ ⁻ (bicarbonate) | |
| | | | | CO ₃ ⁻² (carbonate) | |
| | | | +5 | H ₂ C ₂ O ₆ (perdicarbonic acid) | |
| | | | +6 | H ₂ CO ₄ (permonocarbonic acid) | |
| | | Germanium (Ge) | +4 | H ₂ GeO ₃ (germanic acid) | +4 Species/ +6 Species |
| | | | | HGeO ₃ ⁻ (bigerminate) | |
| | | | | GeO ₃ ⁻⁴ (germinate) | |
| | | | | Ge ⁺⁴ (germanic) | |
| | | Tin (Sn) | +4 | GeO ₄ ⁻⁴ | +4 Species/ +7 Species |
| | | | | H ₂ Ge ₂ O ₅ (digermanic acid) | |
| | | | | H ₂ Ge ₄ O ₉ (tetragermanic acid) | |
| | | | | H ₂ Ge ₅ O ₁₁ (pentagermanic acid) | |
| | | Lead (Pb) | +2 | HGe ₅ O ₁₁ ⁻ (bipentagermanate) | +2, +2.67, +3 Species/+4 Species |
| | | | | Ge ₅ O ₁₁ ⁻² (pentagermanate) | |
| | | | | Sn ⁺⁴ (stannic) | |
| | | | | HSnO ₃ ⁻ (bistannate) | |
| IV | A | Lead (Pb) | +2 | SnO ₃ ⁻² (stannate) | +2, +2.67, +3 Species/+4 Species |
| | | | | SnO ₂ (stannic oxide) | |
| | | | | Sn(OH) ₄ (stannic hydroxide) | |
| | | | | SnO ₄ ⁻ (perstannate) | |
| | | Lead (Pb) | +2 | Pb ⁺² (plumbous) | +2, +2.67, +3 Species/+4 Species |
| | | | | HPbO ₂ ⁻ (biplumbite) | |
| | | | | PbOH ⁺ | |
| | | | | PbO ₂ ⁻² (plumbite) | |
| | | Lead (Pb) | +2.67 | PbO (plumbous oxide) | +2, +2.67, +3 Species/+4 Species |
| | | | | Pb ₃ O ₄ (plumbo-plumbic oxide) | |
| | | | | Pb ₂ O ₃ (sequioxide) | |
| | | | | Pb ⁺⁴ (plumbic) | |
| | | Lead (Pb) | +4 | PbO ₃ ⁻² (metaplumbate) | +2, +2.67, +3 Species/+4 Species |
| | | | | HPbO ₃ ⁻ (acid metaplumbate) | |
| | | | | PbO ₄ ⁻⁴ (orthoplumbate) | |
| | | | | PbO ₂ (dioxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| IV | B | Titanium | +4 | TiO ⁺² (pertitanyl) HTiO ₄ ⁻ titanate TiO ₂ (dioxide) | +4 Species/ +6 Species |
| | | | +6 | TiO ₂ ⁺² (pertitanyl) HTiO ₄ ⁻ (acid pertitanate) TiO ₄ ⁻² (pertitanate) TiO ₃ (peroxide) | |
| | | Zirconium (Zr) | +4 | Zr ⁺⁴ (zirconic) ZrO ⁺² (zirconyl) HZrO ₃ ⁻ (zirconate) | +4 Species/ +5, +6, +7 Species |
| | | | +5 | Zr ₂ O ₅ (pentoxide) | |
| | | | +6 | ZrO ₃ (peroxide) | |
| | | | +7 | Zr ₂ O ₇ (heptoxide) | |
| | | Hafnium (Hf) | +4 | Hf ⁺⁴ (hafnic) HfO ⁺² (hafnyl) | +4 Species/ +6 Species |
| | | | +6 | HfO ₃ (peroxide) | |
| V | A | Nitrogen | +5 | HNO ₃ (nitric acid) NO ₃ ⁻ (nitrate) | +5 species/ +7 Species |
| | | | +7 | HNO ₄ (pernitric acid) | |
| | | Phosphorus (P) | +5 | H ₃ PO ₄ (orthophosphoric acid) H ₂ PO ₄ ⁻ (monoorthophosphate) HPO ₄ ⁻² (diorthophosphate) PO ₄ ⁻³ (triorthophosphate) HPO ₃ (metaphosphoric acid) H ₄ P ₂ O ₇ (pyrophosphoric acid) H ₅ P ₃ O ₁₀ (triphosphoric acid) H ₆ P ₄ O ₁₃ (tetraphosphoric acid) | +5 Species/ +6, +7 species |
| | | | +5 | | |
| V | A | Phosphorus (P) | +6 | H ₄ P ₂ O ₈ (perphosphoric acid) | +5 Species/ +6, +7 Species |
| | | | +7 | H ₃ PO ₅ (monoperphosphoric acid) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| V | A | Arsenic (As) | +5 | H ₃ AsO ₄ (ortho-arsenic acid) H ₂ AsO ₄ ⁻ (mono ortho-arsenate) HAsO ₄ ⁻² (di-ortho-arsenate) AsO ₄ ⁻³ (tri-ortho-arsenate) AsO ₂ ⁺ (arsenyl) | +5 Species/ +7 species |
| | | | +7 | AsO ₃ ⁺ (perarsenyl) | |
| | | Bismuth (Bi) | +3 | Bi ⁺³ (bismuthous) BiOH ⁺² (hydroxybismuthous) BiO ⁺ (bismuthyl) BiO ₂ ⁻ (metabismuthite) | +3 Species/ +3.5, +4, +5 Species |
| | | | +3.5 | Bi ₄ O ₇ (oxide) | |
| | | | +4 | Bi ₂ O ₄ (tetroxide) | |
| | | | +5 | BiO ₃ ⁻ (metabismuthite) Bi ₂ O ₅ (pentoxide) | |
| | B | Vanadium (V) | +5 | VO ₂ ⁺ (vanadic) H ₃ V ₂ O ₇ ⁻ (pyrovanadate) H ₂ VO ₄ ⁻ (orthovanadate) VO ₃ ⁻ (metavanadate) HVO ₄ ⁻² (orthovanadate) VO ₄ ⁻³ (orthovanadate) V ₂ O ₅ (pentoxide) H ₄ V ₂ O ₇ (pyrovanadic acid) HVO ₃ (metavanadic acid) H ₄ V ₆ O ₁₇ (hexavanadic acid) | +5 Species/ +7, +9 Species |
| | | | +7 | VO ₄ ⁻ (pervanadate) | |
| | | | +9 | VO ₅ ⁻ (hypervanadate) | |
| | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| V | B | Niobium (Nb) | +5 | NbO ₃ ⁻ (metaniobate) | +5 Species/ +7 species |
| | | | | NbO ₄ ⁻³ (orthoniobate) Nb ₂ O ₅ (pentoxide) HNbO ₃ (niobid acid) | |
| | | | +7 | NbO ₄ ⁻ (perniobate) Nb ₂ O ₇ (perniobic oxide) HNbO ₄ (perniobic acid) | |
| | | | | | |
| | | Tantalum (Ta) | +5 | TaO ₃ ⁻ (metatantalate) TaO ₄ ⁻³ (orthotantalate) Ta ₂ O ₅ (pentoxide) HTaO ₃ (tantalic acid) | +5 species/ +7 species |
| | | | +7 | TaO ₄ ⁻ (pentantalate) Ta ₂ O ₇ (pertantalate) HTaO ₄ •H ₂ O (pertantalic acid) | |
| VI | A | Sulfur (S) | +6 | H ₂ SO ₄ (sulfuric acid) HSO ₄ ⁻ (bisulfate) SO ₄ ⁻² (sulfate) | +6 Species/ +7, +8 Species |
| | | | | | |
| | | | +7 | S ₂ O ₈ ⁻² (dipersulfate) | |
| | | | +8 | H ₂ SO ₅ (momopersulfuric acid) | |
| | | Selenium (Se) | +6 | H ₂ SeO ₄ (selenic acid) HSeO ₄ ⁻ (biselenate) SeO ₄ ⁻² (selenate) | +6 species/ +7 Species |
| | | | | | |
| | | | +7 | H ₂ Se ₂ O ₈ (perdiselenic acid) | |
| | | Tellurium (Te) | +6 | H ₂ TeO ₄ (telluric acid) HTeO ₄ ⁻ (bitellurate) TeO ₄ ⁻² (tellurate) | +6 species/ +7 species |
| | | | | | |
| | | | +7 | H ₂ Te ₂ O ₈ (perditellenic acid) | |
| | | Polonium (Po) | +2 | Po ⁺² (polonous) | +2, +4 species/ +6 Species |
| | | | +4 | PoO ₃ ⁻² (polonate) | |
| | | | +6 | PoO ₃ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VI | B | Chromium | +3 | Cr^{+3} (chromic) CrOH^{+2} , Cr(OH)_2^+ (chromyls) CrO_2^- , CrO_3^{-3} (chromites) Cr_2O_3 (chromic oxide) Cr(OH)_3 (chromic hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | CrO_2 (dioxide) Cr(OH)_4 (hydroxide) | |
| | | | +6 | H_2CrO_4 (chromic acid) HCrO_4^- (acid chromate) CrO_4^{-2} (chromate) $\text{Cr}_2\text{O}_7^{-2}$ (dichromate) | |
| | | Molybdenum (Mo) | +6 | HMoO_4^- (bimolybdate) MoO_4^{-2} (molybdate) MoO_3 (molybdic trioxide) H_2MoO_4 (molybolic acid) | +6 Species/ +7 Species |
| | | | +7 | MoO_4^- (permolybdate) | |
| | | Tungsten (W) | +6 | WO_4^{-2} tungstic) WO_3 (trioxide) H_2WO_4 (tungstic acid) | +6 Species/ +8 Species |
| | | | +8 | WO_5^{-2} (pertungstic) H_2WO_5 (pertungstic acid) | |
| | | Chlorine (Cl) | -1 | Cl^- (chloride) | -1 Species/ +1, +3, +5, +7 Species |
| | | | +1 | HClO (hypochlorous acid) ClO^- (hypochlorite) | +1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species; +5 Species/ +7 Species |
| | | | +3 | HClO_2 (chlorous acid) ClO_2^- (chlorite) | |
| | | | +5 | HClO_3 (chloric acid) ClO_3^- (chlorate) | |
| | | | +7 | HClO_4 (perchloric acid) ClO_4^- , HClO_5^{-2} , ClO_5^{-3} , $\text{Cl}_2\text{O}_9^{-4}$ (perchlorates) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| VII | A | Bromine (Br) | -1 | Br ⁻ (bromide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HBrO (hypobromous acid) BrO ⁻ (hypobromite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HBrO ₂ (bromous acid) BrO ₂ ⁻ (bromite) | +5 Species/ +7 Species |
| | | | +5 | HBrO ₃ (bromic acid) BrO ₃ ⁻ (bromate) | |
| | | | +7 | HBrO ₄ (perbromic acid) BrO ₄ ⁻ , HBrO ₅ ⁻² , BrO ₅ ⁻³ , Br ₂ O ₉ ⁻⁴ (prebromates) | |
| | | Iodine | -1 | I ⁻ (iodide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HIO (hypoiodous acid) IO ⁻ (hypoiodite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HIO ₂ (iodous acid) IO ₂ ⁻ (iodite) | +5 Species/ +7 Species |
| | | | +5 | HIO ₃ (iodic acid) IO ₃ ⁻ (iodate) | |
| | | | +7 | HIO ₄ (periodic acid) IO ₄ ⁻ , HIO ₅ ⁻² , IO ₅ ⁻³ , I ₂ O ₉ ⁻⁴ (periodates) | |
| | B | Manganese (Mn) | +2 | Mn ⁺² (manganeous) HMnO ₂ ⁻ (dimanganite) | +2 Species/ +3, +4, +6, +7 Species; +3 Species/ +4, +6, +7 Species; |
| | | | +3 | Mn ⁺³ (manganic) | +4 Species/ +6, +7 Species; |
| | | | +4 | MnO ₂ (dioxide) | +6 Species/ +7 Species |
| | | | +6 | MnO ₄ ⁻² (manganate) | |
| | | | +7 | MnO ₄ ⁻ (permanganate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VIII | Period 4 | Iron (Fe) | +2 | Fe^{+2} (ferrous) HFeO_2 (dihydroferrite) | +2 Species/+3, +4, +5, +6 Species; |
| VIII | Period 4 | Iron (Fe) | +3 | Fe^{+3} (ferric) $\text{Fe}(\text{OH})^{+2}$ $\text{Fe}(\text{OH})_2^+$ FeO_2^{-2} (ferrite) | +3 Species/+4, +5, +6 Species; |
| | | | +4 | FeO^{+2} (ferryl) FeO_2^{-2} (perferrite) | +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +5 | FeO_2^+ (perferryl) | |
| | | | +6 | FeO_4^{-2} (ferrate) | |
| | | Cobalt (Co) | +2 | Co^{+2} (cobalous) HCoO_2^- (dicobaltite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Co^{+3} (cobaltic) Co_2O_3 (cobaltic oxide) | |
| | | | +4 | CoO_2 (peroxide) H_2CoO_3 (cobaltic acid) | |
| | | Nickel (Ni) | +2 | Ni^{+2} (nickelous) NiOH^+ HNiO_2^- (dinickelite) NiO_2^{-2} (nickelite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Ni^{+3} (nickelic) Ni_2O_3 (nickelic oxide) | |
| | | | +4 | NiO_2 (peroxide) | |
| | | | +6 | NiO_4^{-2} (nickelate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| VIII | Period 5 | Ruthenium (Ru) | +2 | Ru^{+2} | +2 Species/ +3, +4, +5, +6, +7, +8 Species; |
| | | | +3 | Ru^{+3} Ru_2O_3 (sesquioxide) $\text{Ru}(\text{OH})_3$ (hydroxide) | +3 Species/ +4, +5, +6, +7, +8 Species; +4 Species/ +5, +6, +7, +8 Species; +5 Species/ +6, +7, +8 Species; |
| | | | +4 | Ru^{+4} (ruthenic) RuO_2 (ruthenic dioxide) $\text{Ru}(\text{OH})_4$ (ruthenic hydroxide) | +6 Species/ +7, +8 Species; +7 Species/ +8 Species |
| | | | +5 | Ru_2O_5 (pentoxide) | |
| | | | +6 | RuO_4^{-2} (ruthenate) RuO_2^{+2} (ruthenyl) RuO_3 (trioxide) | |
| | | | +7 | RuO_4^- (perruthenate) | |
| | | | +8 | H_2RuO_4 (hyperuthenic acid) HRuO_5^- (diperruthenate) RuO_4 (ruthenium tetroxide) | |
| | | Rhodium (Rh) | +1 | Rh^+ (hyporhodous) | +1 Species/ +2, +3, +4, +6 Species; |
| | | | +2 | Rh^{+2} (rhodous) | +2 Species/ +3, +4, +6 Species; |
| | | | +3 | Rh^{+3} (rhodic) Rh_2O_3 (sesquioxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | RhO_2 (rhodic oxide) $\text{Rh}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | RhO_4^{-2} (rhodate) RhO_3 (trioxide) | |
| | | Palladium | +2 | Pd^{+2} (palladous) PdO_2^{-2} (palladite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; |
| | | | +3 | Pd_2O_3 (sesquioxide) | +4 Species/ +6 Species |
| | | | +4 | Pd O_3^{-2} (palladate) PdO_2 (dioxide) $\text{Pd}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | PdO_3 (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-------------|-------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| VIII | Period 6 | Iridium (Ir) | +3 | Ir ⁺³ (iridic) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | | Ir ₂ O ₃ (iridium sesquioxide) | |
| | | | | Ir (OH) ₃ (iridium hydroxide) | |
| | | | +4 | IrO ₂ (iridic oxide) Ir (OH) ₄ (iridic hydroxide) | |
| | | | +6 | IrO ₄ ⁻² (iridate) IrO ₃ (iridium peroxide) | |
| | | Platinum (Pt) | +2 | Pt ⁺² (platinous) | +2, +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Pt ₂ O ₃ (sesquioxide) | |
| | | | +4 | PtO ₃ ⁻² (palatinate) PtO ⁺² (platinyI) Pt(OH) ⁺³ PtO ₂ (platinic oxide) | |
| IIIB | Rare earths | Cerium (Ce) | +3 | Ce ⁺³ (cerous) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | | Ce ₂ O ₃ (cerous oxide) | |
| | | | | Ce(OH) ₃ (cerous hydroxide) | |
| | | | +4 | Ce ⁺⁴ , Ce(OH) ⁺³ , Ce(OH) ₂ ⁺² , Ce(OH) ₃ ⁺ (ceric) CeO ₂ (ceric oxide) | |
| | | | +6 | CeO ₃ (peroxide) | |
| | | Praseodymium (Pr) | +3 | Pr ⁺³ (praseodymous) | +3 species/ +4 species |
| | | | | Pr ₂ O ₃ (sesquioxide) Pr(OH) ₃ (hydroxide) | |
| | | | +4 | Pr ⁺⁴ (praseodymic) PrO ₂ (dioxide) | |
| | | Neodymium | +3 | Nd ⁺³ | +3 Species/ +4 Species |
| | | | | Nd ₂ O ₃ (sesquioxide) | |
| | | | +4 | NdO ₂ (peroxide) | |
| | | Terbium (Tb) | +3 | Tb ⁺³ | +3 Species/ +4 Species |
| | | | | Tb ₂ O ₃ (sesquioxide) | |
| | | | +4 | TbO ₂ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| IIIB | Actinides | Thorium (Th) | +4 | Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate) | +4 Species/ +6 Species |
| | | | +6 | ThO ₃ (acid peroxide) | |
| | | Uranium (U) | +6 | UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide) | +6 Species/ +8 Species |
| | | | +8 | HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide) | |
| | | Neptunium (Np) | +5 | NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide) | +5 Species/ +6, +8 Species; +6 Species/ +8 Species |
| | | | +6 | NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide) | |
| | | | +8 | NpO ₄ (peroxide) | |
| | | Plutonium (Pu) | +3 | Pu ⁺³ (hypoplutinous) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Pu ⁺⁴ (plutinous) PuO ₂ (dioxide) | |
| | | | +5 | PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide) | |
| | | | +6 | PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide) | |
| | | Americium (Am) | +3 | Am ⁺³ (hypoamericious) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₄ (hydroxide) | |
| | | | +5 | AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide) | |
| | | | +6 | AmO ₂ ⁺² (americyl) AmO ₃ (peroxide) | |

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

| GROUP | SUB GROUP | ELEMENT |
|-------|-------------|-------------------------------------------------------------------------------|
| I | A | Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs) |
| | B | Copper (Cu), Silver (Ag), and Gold (Au) |
| II | A | Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba) |
| | B | Zinc (Zn), Cadmium (Cd), and Mercury (Hg) |
| III | A | Boron (B), and Aluminum (Al) |
| | B | Scandium (Sc), and Yttrium (Y) – (See Rare Earths) |
| IV | A | Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb) |
| | B | Titanium (Ti), Zirconium (Zr), and Hafnium (Hf) |
| V | A | Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi) |
| | B | Vanadium (V), Niobium (Nb), and Tantalum (Ta) |
| VI | A | Sulfur (S), Selenium (Se), and Tellurium (Te) |
| | B | Chromium (Cr), Molybdenum (Mo), and Tungsten (W) |
| VII | A | Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I) |
| | B | Manganese (Mn), Technetium (Tc), and Rhenium (Re) |
| VIII | Period 4 | Iron (Fe), Cobalt (Co), and Nickel (Ni) |
| | Period 5 | Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd) |
| | Period 6 | Osmium (Os), Iridium (Ir), and Platinum (Pt) |
| IIIB | Rare Earths | All |

wherein the anolyte portion further comprises super oxidizers, ions with an oxidation potential above a threshold value of 1.7 volts at 1 molar, 25°C and pH 1, which generate inorganic free radicals in aqueous solutions, for involving in a secondary oxidation process for producing oxidizers, and organic free radicals for aiding the process and breaking down Sharps I into ions in solution in the anolyte and the biological and organic materials involved with Sharps II and III into simpler smaller molecular structure biological and organic compounds..

99. (Currently amended) Apparatus for treating and oxidizing Sharps I into ions in solution in the anolyte and sterilizing Sharps II and destroying biological and organic waste materials comprising an electrochemical cell, an aqueous electrolyte disposed in the electrochemical cell, a semi permeable membrane, ion selective membrane, ~~microporous membrane~~, porous ceramic or glass frit membrane disposed in the electrochemical cell for separating the cell into anolyte and catholyte chambers and separating the anolyte and catholyte portions, electrodes further comprising an anode and a cathode disposed in the electrochemical

cell respectively in the anolyte and catholyte chambers and in the anolyte and catholyte portions of the electrolyte, a power supply connected to the anode and the cathode for applying a direct current voltage between the anolyte and the catholyte portions of the electrolyte, and oxidizing of the materials in the anolyte portion with a mediated electrochemical oxidation (MEO) process wherein the anolyte portion further comprises a mediator in aqueous solution for producing reversible redox couples used as oxidizing species and the electrolyte is an acid, neutral or alkaline aqueous solution, wherein the mediator oxidizing species are selected from the group consisting of (a.) simple ion redox couples described in Table I as below; (b.) Type I isopolyanions complex anion redox couples formed by incorporation of elements in Table I, or mixtures thereof as addenda atoms; (c.) Type I heteropolyanions complex anion redox couples formed by incorporation into Type I isopolyanions as heteroatoms any element selected from the group consisting of the elements listed in Table II either singly or in combination thereof, or (d.) heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or (e.) combinations of the mediator oxidizing species from any or all of (a.), (b.), (c.), and (d.)

Table I: Simple Ion Redox Couples

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------|---------|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| I | A | None | | | |
| | B | Copper (Cu) | +2 | Cu ²⁺ (cupric) HCuO ₂ (bicuprite) CuO ₂ ⁻² (cuprite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Cu ⁺³ CuO ₂ ⁻ (cuprate) Cu ₂ O ₃ (sesquioxide) | |
| | | | +4 | CuO ₂ (peroxide) | |
| | | Silver (Ag) | +1 | Ag ⁺ (argentous) AgO ⁻ (argentite) | +1 Species/ +2, +3 Species; +2 Species/ +3 Species |
| | | | +2 | Ag ⁺² (argentic) AgO (argentic oxide) | |
| | | | +3 | AgO ⁺ (argetyl) Ag ₂ O ₃ (sesquioxide) | |
| | | Gold (Au) | +1 | Au ⁺ (aurous) | +1 Species/ +3, +4 Species; + 3 Species/ +4 Species |
| | | | +3 | Au ⁺³ (auric) AuO ⁻ (auryl) H ₃ AuO ₃ ⁻ (auric acid) | |

| | | | | | |
|----|---|----------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| | | | | H_2AuO_3^- (monoaurate) HAuO_3^{-2} (diaurate) AuO_3^{-3} (triaurate) Au_2O_3 (auric oxide) $\text{Au}(\text{OH})_3$ (auric hydroxide) | |
| | | | +4 | AuO_2 (peroxide) | |
| II | A | Magnesium (Mg) | +2 | Mg^{+2} (magnesian) | +2 Species/ +4 Species |
| | | | +4 | MgO_2 (peroxide) | |
| | | Calcium (Ca) | +2 | Ca^{+2} | +2 Species/ +4 Species |
| | | | +4 | CaO_2 (peroxide) | |
| | | Strontium | +2 | Sr^{+2} | +2 Species/ +4 Species |
| | | | +4 | SrO_2 (peroxide) | |
| | | Barium (Ba) | +2 | Ba^{+2} | +2 Species/ +4 Species |
| | | | +4 | BaO_2 (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES | | |
|-------|-----------|--------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| II | B | Zinc (Zn) | +2 | Zn ⁺² (zincic) ZnOH ⁺ (zincyl) HZnO ₂ ⁻ (bizincate) ZnO ₂ ⁻² (zincate) | +2 Species/ +4 Species | | |
| | | | +4 | ZnO ₂ (peroxide) | | | |
| | | Mercury (Hg) | +2 | Hg ⁺² (mercuric) Hg (OH) ₂ (mercuric hydroxide) HHgO ₂ ⁻ (mercurete) | +2 Species/ +4 Species | | |
| | | | +4 | HgO ₂ (peroxide) | | | |
| III | A | Boron | +3 | H ₃ BO ₃ (orthoboric acid) H ₂ BO ₃ ⁻ , HBO ₃ ⁻² , BO ₃ ⁻³ (orthoborates) BO ₂ ⁻ (metaborate) H ₂ B ₄ O ₇ (tetraboric acid) HB ₄ O ₇ ⁻ /B ₄ O ₇ ⁻² (tetraborates) B ₂ O ₄ ⁻² (diborate) B ₆ O ₁₀ ⁻² (hexaborate) | +3 Species/ +4.5, +5 Species | | |
| | | | +4.5 | B ₂ O ₅ ⁻ (diborate) | | | |
| | | | +5 | BO ₃ ⁻ /BO ₂ ⁻ •H ₂ O (perborate) | | | |
| | | | Thallium (Tl) | +1 | | Tl ⁺¹ (thallous) | +1 Species/ +3 or +3.33 Species; +3 Species/ +3.33 Species |
| | | | | +3 | | Tl ⁺³ (thallic) TlO ⁺ , TlOH ⁺² , Tl(OH) ₂ ⁺ (thallyl) Tl ₂ O ₃ (sesquioxide) Tl(OH) ₃ (hydroxide) | |
| | | +3.33 | | Tl ₃ O ₅ (peroxide) | | | |
| | | B | See Rare Earths and Actinides | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| IV | A | Carbon (C) | +4 | H ₂ CO ₃ (carbonic acid) HCO ₃ ⁻ (bicarbonate) CO ₃ ⁻² (carbonate) | +4 Species/ +5, +6 Species |
| | | | +5 | H ₂ C ₂ O ₆ (perdicarbonic acid) | |
| | | | +6 | H ₂ CO ₄ (permonocarbonic acid) | |
| | | Germanium (Ge) | +4 | H ₂ GeO ₃ (germanic acid) HGeO ₃ ⁻ (bigermaniate) GeO ₃ ⁻⁴ (germinate) Ge ⁺⁴ (germanic) GeO ₄ ⁻⁴ H ₂ Ge ₂ O ₅ (digermanic acid) H ₂ Ge ₄ O ₉ (tetragermanic acid) H ₂ Ge ₅ O ₁₁ (pentagermanic acid) HGe ₅ O ₁₁ ⁻ (bipentagermanate) | +4 Species/ +6 Species |
| | | | +6 | Ge ₅ O ₁₁ ⁻² (pentagermanate) | |
| | | Tin (Sn) | +4 | Sn ⁺⁴ (stannic) HSnO ₃ ⁻ (bistannate) SnO ₃ ⁻² (stannate) SnO ₂ (stannic oxide) Sn(OH) ₄ (stannic hydroxide) | +4 Species/ +7 Species |
| | | | +7 | SnO ₄ ⁻ (perstannate) | |
| | | Lead (Pb) | +2 | Pb ⁺² (plumbous) HPbO ₂ ⁻ (biplumbite) PbOH ⁺ PbO ₂ ⁻² (plumbite) PbO (plumbus oxide) | +2, +2.67, +3 Species/+4 Species |
| | | | +2.67 | Pb ₃ O ₄ (plumbo-plumbic oxide) | |
| | | | +3 | Pb ₂ O ₃ (sequioxide) | |
| | | Lead (Pb) | +4 | Pb ⁺⁴ (plumbic) | +2, +2.67, +3 Species/+4 Species |
| | | | | PbO ₃ ⁻² (metaplumbate) | |
| | | | | HPbO ₃ ⁻ (acid metaplumbate) | |
| | | | | PbO ₄ ⁻⁴ (orthoplumbate) | |
| | | | | PbO ₂ (dioxide) | |
| IV | A | Lead (Pb) | +4 | Pb ⁺⁴ (plumbic) | +2, +2.67, +3 Species/+4 Species |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| IV | B | Titanium | +4 | TiO ⁺² (pertitanyl) HTiO ₄ ⁻ (titanate) TiO ₂ (dioxide) | +4 Species/ +6 Species |
| | | | +6 | TiO ₂ ⁺² (pertitanyl) HTiO ₄ ⁻ (acid pertitanate) TiO ₄ ⁻² (pertitanate) TiO ₃ (peroxide) | |
| | | Zirconium (Zr) | +4 | Zr ⁺⁴ (zirconic) ZrO ⁺² (zirconyl) HZrO ₃ ⁻ (zirconate) | +4 Species/ +5, +6, +7 Species |
| | | | +5 | Zr ₂ O ₅ (pentoxide) | |
| | | | +6 | ZrO ₃ (peroxide) | |
| | | | +7 | Zr ₂ O ₇ (heptoxide) | |
| | | Hafnium (Hf) | +4 | Hf ⁺⁴ (hafnic) HfO ⁺² (hafnyl) | +4 Species/ +6 Species |
| | | | +6 | HfO ₃ (peroxide) | |
| V | A | Nitrogen | +5 | HNO ₃ (nitric acid) NO ₃ ⁻ (nitrate) | +5 species/ +7 Species |
| | | | +7 | HNO ₄ (pernitric acid) | |
| | | Phosphorus (P) | +5 | H ₃ PO ₄ (orthophosphoric acid) H ₂ PO ₄ ⁻ (monoorthophosphate) HPO ₄ ⁻² (diorthophosphate) PO ₄ ⁻³ (triorthophosphate) HPO ₃ (metaphosphoric acid) H ₄ P ₂ O ₇ (pyrophosphoric acid) H ₅ P ₃ O ₁₀ (triphosphoric acid) H ₆ P ₄ O ₁₃ (tetraphosphoric acid) | +5 Species/ +6, +7 species |
| | | | | | |
| V | A | Phosphorus (P) | +6 | H ₄ P ₂ O ₈ (perphosphoric acid) | +5 Species/ +6, +7 Species |
| | | | +7 | H ₃ PO ₅ (monoperphosphoric acid) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| V | A | Arsenic (As) | +5 | H ₃ AsO ₄ (ortho-arsenic acid) H ₂ AsO ₄ ⁻ (mono ortho-arsenate) HAsO ₄ ⁻² (di-ortho-arsenate) AsO ₄ ⁻³ (tri-ortho-arsenate) AsO ₂ ⁺ (arsenyl) | +5 Species/ +7 species |
| | | | +7 | AsO ₃ ⁺ (perarsenyl) | |
| | | Bismuth (Bi) | +3 | Bi ⁺³ (bismuthous) BiOH ⁺² (hydroxybismuthous) BiO ⁺ (bismuthyl) BiO ₂ ⁻ (metabismuthite) | +3 Species/ +3.5, +4, +5 Species |
| | | | +3.5 | Bi ₄ O ₇ (oxide) | |
| | | | +4 | Bi ₂ O ₄ (tetroxide) | |
| | | | +5 | BiO ₃ ⁻ (metabismuthite) Bi ₂ O ₅ (pentoxide) | |
| | | | | | |
| | B | Vanadium (V) | +5 | VO ₂ ⁺ (vanadic) H ₃ V ₂ O ₇ ⁻ (pyrovanadate) H ₂ VO ₄ ⁻ (orthovanadate) VO ₃ ⁻ (metavanadate) HVO ₄ ⁻² (orthovanadate) VO ₄ ⁻³ (orthovanadate) V ₂ O ₅ (pentoxide) H ₄ V ₂ O ₇ (pyrovanadic acid) HVO ₃ (metavanadic acid) H ₄ V ₆ O ₁₇ (hexavanadic acid) | +5 Species/ +7, +9 Species |
| | | | +7 | VO ₄ ⁻ (pervanadate) | |
| | | | +9 | VO ₅ ⁻ (hypervanadate) | |
| | | | | | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| V | B | Niobium (Nb) | +5 | NbO ₃ ⁻ (metaniobate) | +5 Species/ +7 species |
| | | | | NbO ₄ ⁻³ (orthoniobate) Nb ₂ O ₅ (pentoxide) HNbO ₃ (niobid acid) | |
| | | | +7 | NbO ₄ ⁻ (perniobate) Nb ₂ O ₇ (perniobic oxide) HNbO ₄ (perniobic acid) | |
| | | | | | |
| | | Tantalum (Ta) | +5 | TaO ₃ ⁻ (metatantalate) TaO ₄ ⁻³ (orthotantalate) Ta ₂ O ₅ (pentoxide) HTaO ₃ (tantalic acid) | +5 species/ +7 species |
| | | | | | |
| | | | +7 | TaO ₄ ⁻ (pentantalate) Ta ₂ O ₇ (pertantalate) HTaO ₄ •H ₂ O (pertantalic acid) | |
| | | | | | |
| VI | A | Sulfur (S) | +6 | H ₂ SO ₄ (sulfuric acid) HSO ₄ ⁻ (bisulfate) SO ₄ ⁻² (sulfate) | +6 Species/ +7, +8 Species |
| | | | | | |
| | | | +7 | S ₂ O ₈ ⁻² (dipersulfate) | |
| | | | +8 | H ₂ SO ₅ (momopersulfuric acid) | |
| | | Selenium (Se) | +6 | H ₂ Se ₂ O ₄ (selenic acid) HSeO ₄ ⁻ (biselenate) SeO ₄ ⁻² (selenate) | +6 species/ +7 Species |
| | | | | | |
| | | | +7 | H ₂ Se ₂ O ₃ (perdiselenic acid) | |
| | | Tellurium (Te) | +6 | H ₂ TeO ₄ (telluric acid) HTeO ₄ ⁻ (bitellurate) TeO ₄ ⁻² (tellurate) | +6 species/ +7 species |
| | | | | | |
| | | | +7 | H ₂ Te ₂ O ₈ (perditellenic acid) | |
| | | Polonium (Po) | +2 | Po ⁺² (polonous) | +2, +4 species/ +6 Species |
| | | | +4 | PoO ₃ ⁻² (polonate) | |
| | | | +6 | PoO ₃ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| VI | B | Chromium | +3 | Cr ⁺³ (chromic) CrOH ⁺² , Cr(OH) ₂ ⁺ (chromyls) CrO ₂ ⁻ , CrO ₃ ⁻³ (chromites) Cr ₂ O ₃ (chromic oxide) Cr(OH) ₃ (chromic hydroxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | CrO ₂ (dioxide) Cr(OH) ₄ (hydroxide) | |
| | | | +6 | H ₂ CrO ₄ (chromic acid) HCrO ₄ ⁻ (acid chromate) CrO ₄ ⁻² (chromate) Cr ₂ O ₇ ⁻² (dichromate) | |
| | | Molybdenum (Mo) | +6 | HMoO ₄ ⁻ (bimolybdate) MoO ₄ ⁻² (molybdate) MoO ₃ (molybdic trioxide) H ₂ MoO ₄ (molybolic acid) | +6 Species/ +7 Species |
| | | | +7 | MoO ₄ ⁻ (permolybdate) | |
| | | Tungsten (W) | +6 | WO ₄ ⁻² tungstic) WO ₃ (trioxide) H ₂ WO ₄ (tungstic acid) | +6 Species/ +8 Species |
| | | | +8 | WO ₅ ⁻² (pertungstic) H ₂ WO ₅ (pertungstic acid) | |
| VII | A | Chlorine (Cl) | -1 | Cl ⁻ (chloride) | -1 Species/ +1, +3, +5, +7 Species |
| | | | +1 | HClO (hypochlorous acid) ClO ⁻ (hypochlorite) | +1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HClO ₂ (chlorous acid) ClO ₂ ⁻ (chlorite) | +5 Species/ +7 Species |
| | | | +5 | HClO ₃ (chloric acid) ClO ₃ ⁻ (chlorate) | |
| | | | +7 | HClO ₄ (perchloric acid) ClO ₄ ⁻ , HClO ₅ ⁻² , ClO ₅ ⁻³ , Cl ₂ O ₉ ⁻⁴ (perchlorates) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| VII | A | Bromine (Br) | -1 | Br ⁻ (bromide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HBrO (hypobromous acid) BrO ⁻ (hypobromite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HBrO ₂ (bromous acid) BrO ₂ ⁻ (bromite) | +5 Species/ +7 Species |
| | | | +5 | HBrO ₃ (bromic acid) BrO ₃ ⁻ (bromate) | |
| | | | +7 | HBrO ₄ (perbromic acid) BrO ₄ ⁻ , HBrO ₅ ⁻² , BrO ₅ ⁻³ , Br ₂ O ₉ ⁻⁴ (prebromates) | |
| | | Iodine | -1 | I ⁻ (iodide) | -1 Species/+1, +3, +5, +7 Species; |
| | | | +1 | HIO (hypoiodous acid) IO ⁻ (hypoiodite) | +1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; |
| | | | +3 | HIO ₂ (iodous acid) IO ₂ ⁻ (iodite) | +5 Species/ +7 Species |
| | | | +5 | HIO ₃ (iodic acid) IO ₃ ⁻ (iodate) | |
| | | | +7 | HIO ₄ (periodic acid) IO ₄ ⁻ , HIO ₅ ⁻² , IO ₅ ⁻³ , I ₂ O ₉ ⁻⁴ (periodates) | |
| | B | Manganese (Mn) | +2 | Mn ⁺² (manganeous) HMnO ₂ ⁻ (dimanganite) | +2 Species/ +3, +4, +6, +7 Species; +3 Species/ +4, +6, +7 Species; |
| | | | +3 | Mn ⁺³ (manganic) | +4 Species/ +6, +7 Species; |
| | | | +4 | MnO ₂ (dioxide) | +6 Species/ +7 Species |
| | | | +6 | MnO ₄ ⁻² (manganate) | |
| | | | +7 | MnO ₄ ⁻ (permanganate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| VIII | Period 4 | Iron (Fe) | +2 | Fe^{+2} (ferrous) HFeO_2 (dihypoferrite) | +2 Species/+3, +4, +5, +6 Species; |
| | | | +3 | Fe^{+3} (ferric) $\text{Fe}(\text{OH})^{+2}$ $\text{Fe}(\text{OH})_2^+$ FeO_2^{-2} (ferrite) | +3 Species/+4, +5, +6 Species; |
| | Period 4 | Iron (Fe) | +4 | FeO^{+2} (ferryl) FeO_2^{-2} (perferrite) | +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +5 | FeO_2^+ (perferryl) | |
| | | | +6 | FeO_4^{-2} (ferrate) | |
| | | | | | |
| | | Cobalt (Co) | +2 | Co^{+2} (cobalous) HCoO_2^- (dicobaltite) | +2 Species/ +3, +4 Species; +3 Species/ +4 Species |
| | | | +3 | Co^{+3} (cobaltic) Co_2O_3 (cobaltic oxide) | |
| | | | +4 | CoO_2 (peroxide) H_2CoO_3 (cobaltic acid) | |
| | | Nickel (Ni) | +2 | Ni^{+2} (nickelous) NiOH^+ HNiO_2^- (dinickelite) NiO_2^{-2} (nickelite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Ni^{+3} (nickelic) Ni_2O_3 (nickelic oxide) | |
| | | | +4 | NiO_2 (peroxide) | |
| | | | +6 | NiO_4^{-2} (nickelate) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| VIII | Period 5 | Ruthenium (Ru) | +2 | Ru^{+2} | +2 Species/ +3, +4, +5, +6, +7, +8 Species; |
| | | | +3 | Ru^{+3} Ru_2O_3 (sesquioxide) $\text{Ru}(\text{OH})_3$ (hydroxide) | +3 Species/ +4, +5, +6, +7, +8 Species; +4 Species/ +5, +6, +7, +8 Species; +5 Species/ +6, +7, +8 Species; |
| | | | +4 | Ru^{+4} (ruthenic) RuO_2 (ruthenic dioxide) $\text{Ru}(\text{OH})_4$ (ruthenic hydroxide) | +6 Species/ +7, +8 Species; +7 Species/ +8 Species |
| | | | +5 | Ru_2O_5 (pentoxide) | |
| | | | +6 | RuO_4^{-2} (ruthenate) RuO_2^{+2} (ruthenyl) RuO_3 (trioxide) | |
| | | | +7 | RuO_4^- (perruthenate) | |
| | | | +8 | H_2RuO_4 (hyperuthenic acid) HRuO_5^- (diperruthenate) RuO_4 (ruthenium tetroxide) | |
| | | Rhodium (Rh) | +1 | Rh^+ (hyporhodous) | +1 Species/ +2, +3, +4, +6 Species; |
| | | | +2 | Rh^{+2} (rhodous) | +2 Species/ +3, +4, +6 Species; |
| | | | +3 | Rh^{+3} (rhodic) Rh_2O_3 (sesquioxide) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +4 | RhO_2 (rhodic oxide) $\text{Rh}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | RhO_4^{-2} (rhodate) RhO_3 (trioxide) | |
| | | Palladium | +2 | Pd^{+2} (palladous) PdO_2^{-2} (palladite) | +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; |
| | | | +3 | Pd_2O_3 (sesquioxide) | +4 Species/ +6 Species |
| | | | +4 | PdO_3^{-2} (palladate) PdO_2 (dioxide) $\text{Pd}(\text{OH})_4$ (hydroxide) | |
| | | | +6 | PdO_3 (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-------------|-------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| VIII | Period 6 | Iridium (Ir) | +3 | Ir ⁺³ (iridic) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | | Ir ₂ O ₃ (iridium sesquioxide) | |
| | | | | Ir (OH) ₃ (iridium hydroxide) | |
| | | | +4 | IrO ₂ (iridic oxide) Ir (OH) ₄ (iridic hydroxide) | |
| | | | +6 | IrO ₄ ⁻² (iridate) | |
| | | | | IrO ₃ (iridium peroxide) | |
| | | Platinum (Pt) | +2 | Pt ⁺² (platinous) | +2, +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | +3 | Pt ₂ O ₃ (sesquioxide) | |
| | | | +4 | PtO ₃ ⁻² (palatinate) PtO ⁺² (platinyI) Pt(OH) ⁺³ PtO ₂ (platonc oxide) | |
| IIIB | Rare carths | Cerium (Ce) | +3 | Ce ⁺³ (cerous) | +3 Species/ +4, +6 Species; +4 Species/ +6 Species |
| | | | | Ce ₂ O ₃ (cerous oxide) | |
| | | | | Ce(OH) ₃ (cerous hydroxide) | |
| | | | +4 | Ce ⁺⁴ , Ce(OH) ⁺³ , Ce(OH) ₂ ⁺² , Ce(OH) ₃ ⁺ (ceric) | |
| | | | | CeO ₂ (ceric oxide) | |
| | | | | CeO ₃ (peroxide) | |
| | | Praseodymium (Pr) | +3 | Pr ⁺³ (praseodymous) | +3 species/ +4 species |
| | | | | Pr ₂ O ₃ (sesquioxide) | |
| | | | | Pr(OH) ₃ (hydroxide) | |
| | | Neodymium | +3 | Pr ⁺⁴ (praseodymic) PrO ₂ (dioxide) | +3 Species/ +4 Species |
| | | | | Nd ⁺³ | |
| | | | | Nd ₂ O ₃ (sesquioxide) | |
| | | Terbium (Tb) | +3 | NdO ₂ (peroxide) | +3 Species/ +4 Species |
| | | | | Tb ⁺³ | |
| | | | | Tb ₂ O ₃ (sesquioxide) | |
| | | | +4 | TbO ₂ (peroxide) | |

| GROUP | SUB GROUP | ELEMENT | VALENCE | SPECIES | SPECIFIC REDOX COUPLES |
|-------|-----------|----------------|---------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| IIIB | Actinides | Thorium (Th) | +4 | Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate) | +4 Species/ +6 Species |
| | | | +6 | ThO ₃ (acid peroxide) | |
| | | Uranium (U) | +6 | UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide) | +6 Species/ +8 Species |
| | | | +8 | HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide) | |
| | | Neptunium (Np) | +5 | NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide) | +5 Species/ +6, +8 Species; +6 Species/ +8 Species |
| | | | +6 | NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide) | |
| | | | +8 | NpO ₄ (peroxide) | |
| | | Plutonium (Pu) | +3 | Pu ⁺³ (hypoplutinous) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Pu ⁺⁴ (plutinous) PuO ₂ (dioxide) | |
| | | | +5 | PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide) | |
| | | | +6 | PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide) | |
| | | Americium (Am) | +3 | Am ⁺³ (hypoamericious) | +3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species |
| | | | +4 | Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₄ (hydroxide) | |
| | | | +5 | AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide) | |
| | | | +6 | AmO ₂ ⁺² (americyl) AmO ₃ (peroxide) | |

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

| GROUP | SUB GROUP | ELEMENT |
|-------|-------------|-------------------------------------------------------------------------------|
| I | A | Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs) |
| | B | Copper (Cu), Silver (Ag), and Gold (Au) |
| II | A | Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba) |
| | B | Zinc (Zn), Cadmium (Cd), and Mercury (Hg) |
| III | A | Boron (B), and Aluminum (Al) |
| | B | Scandium (Sc), and Yttrium (Y) – (See Rare Earths) |
| IV | A | Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb) |
| | B | Titanium (Ti), Zirconium (Zr), and Hafnium (Hf) |
| V | A | Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi) |
| | B | Vanadium (V), Niobium (Nb), and Tantalum (Ta) |
| VI | A | Sulfur (S), Selenium (Se), and Tellurium (Te) |
| | B | Chromium (Cr), Molybdenum (Mo), and Tungsten (W) |
| VII | A | Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I) |
| | B | Manganese (Mn), Technetium (Tc), and Rhenium (Re) |
| VIII | Period 4 | Iron (Fe), Cobalt (Co), and Nickel (Ni) |
| | Period 5 | Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd) |
| | Period 6 | Osmium (Os), Iridium (Ir), and Platinum (Pt) |
| IIIB | Rare Earths | All |

further comprising additives disposed in the electrolyte for contributing to kinetics of the mediated electrochemical processes while keeping it from becoming directly involved in the oxidizing of the biological and organic waste materials, and stabilizer compounds disposed in the electrolyte for stabilizing higher oxidation state species of oxidized forms of the reversible redox couples used as the oxidizing species in the electrolyte, wherein the stabilizing compounds are tellurate or periodate ions.

100. (Previously presented) The process of claim 96, wherein the mediator oxidizing species are simple ions redox couple mediators described in Table I; Type I isopolyanions formed by Mo, W, V, Nb, Ta, or mixtures thereof.

101. (Previously presented) The apparatus of claim 99, wherein an aqueous anolyte electrolyte solution comprises an alkaline solution for aiding decomposing the biological and organic waste materials, for absorbing CO₂, for forming alkali metal bicarbonate/carbonate for circulating through the electrochemical cell, and for producing a percarbonate oxidizer.

102 (Previously presented) The apparatus of claim 99, further comprising an AC source for impression of an AC voltage upon a DC voltage to retard the formation of cell performance limiting surface films on the electrodes.

103. (Previously presented) The apparatus of claim 99, wherein the power supply energizes an electrochemical cell at a potential level sufficient to form an oxidized form of a redox couple having the highest oxidation potential in an aqueous anolyte electrolyte solution, and further comprising a heat exchanger connected to an anolyte reaction chamber for controlling temperature between 0°C and slightly below the boiling temperature of an aqueous anolyte electrolyte solution before the aqueous anolyte electrolyte solution enters the electrochemical cell enhancing the generation of oxidized forms of the ion redox couple mediator, and adjusting the temperature of an aqueous anolyte electrolyte solution to the range between 0°C and slightly below the boiling temperature when entering the anolyte reaction chamber.

104. (Previously presented) The apparatus of claim 99, wherein the oxidizing species are one or more Type I isopolyanion complex anion redox couple mediators containing tungsten, molybdenum, vanadium, niobium, tantalum, or combinations thereof as addenda atoms in aqueous solution.

105. (Previously presented) The apparatus of claim 99, further comprising an off-gas cleaning system, comprising scrubber/absorption columns connected to a vent, a condenser connected to an anolyte reaction chamber, whereby non-condensable incomplete oxidation products, low molecular weight organics and carbon monoxide are reduced to acceptable levels for atmospheric release by a gas cleaning system, and wherein an anolyte off-gas is contacted in an off-gas cleaning system wherein the noncondensibles from the condenser are introduced into the lower portion of the off-gas cleaning system through a flow distribution system and a small side stream of freshly oxidized aqueous anolyte electrolyte solution direct from an electrochemical cell is introduced into the upper portion of the column, resulting in a gas phase continuously reacting with the oxidizing mediator species as it rises up the column past the downflowing aqueous anolyte electrolyte solution, and external drain, for draining to an organic compound removal system and an inorganic compounds removal and treatment system, and for draining the anolyte system, wherein an organic compounds recovery system is used to recover

biological materials that are benign and do not need further treatment, and biological materials that will be used in the form they have been reduced.

106. (Previously presented) The apparatus of claim 99, further comprising a thermal control unit connected to heat or cool an aqueous anolyte electrolyte solution to a selected temperature range when the aqueous anolyte electrolyte solution is circulated into an anolyte reaction chamber through the electrochemical cell by pump on the anode chamber side of the membrane, a flush for flushing an aqueous anolyte electrolyte solution, and a filter located at the base of the anolyte reaction chamber to limit the size of exiting solid particles to approximately 1mm in diameter, further comprising a thermal control unit connected to heat or cool an aqueous catholyte electrolyte solution to a selected temperature range when the aqueous catholyte electrolyte solution is circulated into a catholyte reservoir through the electrochemical cell by pump on the cathode chamber side of the membrane.

107. (Previously presented) The apparatus of claim 99, further comprising an aqueous anolyte electrolyte solution and an independent aqueous catholyte electrolyte solution containment boundary composed of materials resistant to the electrolyte selected from a group consisting of stainless steel, PTFE, PTFE lined tubing, glass and ceramics, or combinations thereof.

108. (Previously presented) The apparatus of claim 99, further comprising an off-gas cleaning system connected to a catholyte reservoir for cleaning gases before release into the atmosphere and an atmospheric vent connected to the off-gas cleaning system for releasing gases into the atmosphere, wherein cleaned gas from the off-gas cleaning system is combined with unreacted components of the air introduced into the system and discharged through the atmospheric vent.

109. (Previously presented) The apparatus of claim 99, further comprising a screwed top on a catholyte reservoir to facilitate flushing out the catholyte reservoir, a mixer connected to the catholyte reservoir for stirring an aqueous catholyte electrolyte solution, a catholyte pump connected to the catholyte reservoir for circulating an aqueous catholyte electrolyte solution back to the electrochemical cell, a drain for draining an aqueous catholyte electrolyte solution, a flush for flushing the catholyte system, and an air sparge connected to the housing for introducing air into the catholyte reservoir, wherein an aqueous catholyte electrolyte solution is circulated by pump through an electrochemical cell on the cathode side of the membrane, and wherein contact

of oxidizing gas with an aqueous catholyte electrolyte solution is enhanced by promoting gas/liquid contact by mechanical and/or ultrasonic mixing.

110. (Previously presented) The apparatus of claim 99, wherein an electrochemical cell is operated at high membrane current densities above about 0.5 amps/cm² for increasing a rate of waste destruction, also results in increased mediator ion transport through a membrane into an aqueous catholyte electrolyte solution, and further comprising an anolyte recovery system positioned on the catholyte side, air sparging on the catholyte side to dilute and remove off-gas and hydrogen, wherein some mediator oxidizer ions cross the membrane and are removed through the anolyte recovery system to maintain process efficiency or cell operability.